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PUBLIC HEALTH ASSESSMENT

ALBION-SHERIDAN TOWNSHIP LANDFILL
SHERIDAN TOWNSHIP, CALHOUN COUNTY, MICHIGAN
CERCLIS No. MID980504450

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Prepared By:

Michigan Department of Community Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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LIST OF ACRONYMS AND ABBREVIATIONS

ASTL	Albion-Sheridan Township Landfill
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	all-terrain vehicle
BEHP	bis(2-ethylhexyl)phthalate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CREG	cancer risk evaluation guide, ATSDR
DNOP	di-n-octyl phthalate
EMEG	environmental media evaluation guide, ATSDR
EPA	Environmental Protection Agency
FS	feasibility study
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System, EPA database
LOAEL	lowest-observed-adverse-effect level
LTHA	Lifetime health advisory, EPA
MCL	Maximum contaminant level, EPA
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
MDL	method detection limit
MDNR	Michigan Department of Natural Resources
MDPH	Michigan Department of Public Health
MRL	minimal risk level, ATSDR
NOAEL	no-observed-adverse-effect level
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHAP	public health action plan
ppb	parts per billion
ppm	parts per million
PRP	potentially responsible party
PRRA	presumptive remedy risk assessment
RfC	reference concentration, EPA
RfD	reference dose, EPA

RfD	reference dose, EPA
RI	remedial investigation
RMEG	reference dose media evaluation guide, ATSDR
ROD	record of decision
SEER	Surveillance, Epidemiology, and End Results Program, National Cancer Institute
SMCL	secondary maximum contaminant level, EPA
SMR	standard mortality ratio
TRI	Toxic Chemical Release Inventory
VOC	volatile organic compound

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SUMMARY

The Albion-Sheridan Township Landfill site was placed on the Environmental Protection Agency's National Priorities List on October 4, 1989. The site is an inactive landfill 1 mile east of the city of Albion, Michigan. The site was originally mined for gravel, with some unauthorized and uncontrolled dumping of waste. The landfill officially operated from 1966 to 1981, accepting both municipal and industrial wastes. After the landfill was closed in 1981, it was covered with local surface materials, primarily sand and gravel. Between 1981 and 1985, part of the landfill property was used as a waste transfer station. The waste transfer station area is not considered part of the Superfund site.

Barrels of wastes were found on the surface of the closed landfill in 1986. The contents of these barrels included hazardous chemicals and flammable or explosive materials. In 1990, the potentially responsible parties for the site removed 46 barrels from the site for off-site disposal. The site was partially fenced in 1990 and later completed in 1992. Apparently abandoned machinery, construction debris, and other trash litter the site.

The groundwater and surface soil at the site are contaminated with various metals and organic chemicals. No contamination associated with the site has reached nearby residential wells. Residents of a community near the landfill have expressed concerns about a perceived increased incidence of cancer and other illness in their community. Investigation of these accounts has not to date identified the source for the concerns, and available cancer incidence data do not indicate an elevated incidence of cancer in the site area.

Under current conditions, the site does not pose any apparent public health hazard. The site did pose a public health hazard in the past while it was still accessible because trespassers were possibly exposed to the metals in the surface soil. A potential public health hazard exists for children subject to pica behavior; these children might ingest enough metals from the soil around a residence on former landfill property south of the landfill to incur a slight risk of adverse health effects. No children are currently living in this residence, although future occupants might include children. This public health assessment recommends that the remediation of the site provide for the control of off-site migration of contaminants and that residential and monitoring wells near the site be regularly sampled to detect migration of the contaminant plume. The Agency for Toxic Substances and Disease Registry, the Michigan Department of Community Health, and county health departments will develop a program of health education to address the health concerns expressed by the community around the site.

BACKGROUND

The Albion-Sheridan Township Landfill (ASTL) site was placed on the Environmental Protection Agency's (EPA) National Priorities List (NPL) on October 4, 1989.

A. Site Description and History

The ASTL site is an inactive landfill in a 30-acre parcel 1 mile east of the city of Albion. The site is between Michigan Avenue (M-99) and Erie Road, on the Calhoun County side of the Calhoun-Jackson County Line (Figure 1). Before 1966, the site was used as a gravel borrow pit and as an uncontrolled dump. In 1966, the owner obtained a state license to operate a landfill on the site, which accepted municipal refuse and industrial wastes from Albion and nearby Sheridan Township. In the early 1970s, the owner received approval from the Michigan Department of Natural Resources (MDNR) to accept metal plating sludges described as insoluble hydroxides and carbonates. Some sources estimate as much as 6,000 cubic yards of sludges were accepted. In addition to these metallic sludges, materials believed

to have been disposed of at the landfill include paint wastes and thinners, consisting of dried paint residues and waste thinner similar to "turpoline"; oil and grease; and dust, sands, and soil, containing fly ash and casting sands from a nearby foundry. The landfill was closed in 1981, and the property was divided for sale as shown in Figure 2 (taken from Reference 1, Figure 2). Records and aerial photographs examined by the EPA's remedial investigation (RI) contractors indicate that the landfill was initially centered in Parcel C in Figure 2 and eventually spread into Parcels A and E, covering 18 acres of the 30-acre property. Parcel B was used as a waste transfer station between 1981 and 1985. The area of the waste transfer station is not considered part of the Superfund site, and any environmental contamination found there will be addressed separately.

Tests conducted in 1980 indicated that the sludges contained high levels of chromium, cadmium, lead, nickel, and cyanide. During an inspection in March 1986, EPA found approximately 40 drums at the site. Some drums were leaking and appeared to be filled with oil and grease wastes. An empty tank of approximately 8,000-gallon capacity was also observed on the site (2)[1]. The nature of the former contents of the tank is not known. Waste deposits in the landfill were found to be 15 to 35 feet deep in wells drilled during the EPA contractors' field work for the RI in 1992 (1). The landfill is covered with between 1 and 2 feet of sand and gravel (based on measurements made during the RI in 1992 [3] and on MDNR test-pitting activities in 1994 [4]), and indications of burning are evident on the site. Vegetation, very dense in some places, is growing on the landfill cover.

An EPA technical assistance team investigated the site on October 12, 1989, at the request of the Agency for Toxic Substances and Disease Registry (ATSDR). Results of the samples taken from four barrels during that visit tentatively identified ignitable hazardous waste (flash point less than 75F) in three barrels and five volatile organic compounds (VOCs) in the other barrel sample (5). In the summer of 1990, two potentially responsible parties (PRPs) for the site, under a unilateral administrative order from EPA, removed 22 full and 24 empty drums from the site, and installed fencing at several entrances to the site (6). The work plan for the remedial investigation/feasibility study (RI/FS) for this site was prepared in August 1992 (7). Field work for the RI was carried out in the fall of 1992 through the spring of 1993. The final RI report was released in April 1994 (1). As part of the RI field work, a fence was installed around most of the site, except for Parcel D (see Figure 2) and a portion of Parcel C. The latter portion, which includes a segment of the landfill, had recently been sold to the owner of Parcel D, who refused to grant an easement across his property (8).

In July 1994, EPA's RI contractors issued a presumptive remedy risk assessment (PRRA) for the site. In the PRRA, the contractors calculated the risks assuming that the landfill would be properly capped to eliminate any contact with contaminated surface material on the site. They concluded that the residents of the site area who used existing residential wells would not incur any significant risk of noncancer adverse health effects. The residents would incur an increased cancer risk below the EPA acceptable risk level of 1 in 10,000, although the increased risk would exceed the Michigan Department of Environmental Quality (MDEQ)[2] acceptable risk level of 1 in 100,000, primarily because of arsenic in the surface soil. The arsenic concentrations in the soil near the site were comparable to background levels (9).

To estimate the risk from the maximum possible exposure to contaminants at the site, the PRRA contractors calculated the risk assuming a new residential well drew water from the contaminant plume on or near the site. A person who uses water from such a well might incur a significant risk of noncancer adverse health effects and an increased cancer risk in excess of the EPA and MDEQ acceptable risk levels from the arsenic, antimony, thallium, and 1,2-dibromo-3-chloropropane in the groundwater (9). In September 1994, EPA's RI contractors issued the feasibility study report for the site (10).

In October and November 1993, MDNR conducted a magnetometer survey of the landfill. The survey identified several magnetic anomalies, indicating possible buried metal. MDNR personnel also noted an area of visible, partially buried drums on the landfill, coinciding with one of the magnetic anomalies. In January 1994, MDNR and EPA were negotiating the removal of these drums (11). In June 1994, MDNR excavated test pits in the landfill and concluded that 200 to 400 drums could also be buried in the landfill (4).

On March 28, 1995, EPA signed a record of decision (ROD) for the remediation of the ASTL site. The remedy includes removing approximately 200 drums of hazardous liquid wastes for off-site disposal, constructing a cap including a gas treatment system for the landfill, consolidating the waste away from private homes, monitoring the groundwater contamination through monitoring and residential wells, and issuing a temporary advisory against use of the contaminated groundwater. EPA expects natural processes to reduce the contamination in the groundwater. If the contaminant concentrations have not decreased after 5 years, a groundwater treatment system will be constructed and implemented (12).

Two aquifers are beneath the site. The upper aquifer consists of unconsolidated glacial deposits. These deposits of sand and gravel range in thickness from 41 to 90 feet. Underlying the glacial deposits is the Marshall Formation, a sandstone bedrock. Both of these aquifer units are used as drinking water sources. A noncontinuous clay layer is between the two units. These two aquifers are believed to be hydraulically connected. The top 5 to 30 feet (depending upon location) of the sandstone shows signs of weathering. The EPA's RI contractors described the groundwater at the site as occurring in three units: the shallow glacial, the weathered bedrock, and the deeper bedrock. The water table in the upper aquifer is found at 10 feet below the surface. Groundwater in all three units flows in a south to southwesterly direction, toward and discharging into the Kalamazoo River. The groundwater flow in the shallow glacial aquifer is strongly affected by this river. Under the landfill, the flow is southwestward, turning southward as it nears the river.

The Michigan Department of Public Health (MDPH),[3] under a cooperative agreement with ATSDR, prepared a preliminary health assessment for this site on September 10, 1990. The preparers of the preliminary health assessment concluded that the site was of potential public health concern because of possible past and future exposure to the contaminants through direct contact, incidental ingestion, and inhalation of contaminated surface material. Restricting site access, removing drums from the site, monitoring groundwater near the site, and sampling surface water and sediment were recommended. Further health studies of residents in the vicinity of the site were not recommended; although possible past and present human exposure to contaminants was indicated, no evidence supported that exposure had actually occurred (13).

B. Site Visits

MDPH staff visited the site in February 1989. Brendan Boyle of MDPH, Calhoun County Health Department personnel, and personnel from an EPA contractor toured the site in October 1989. During the October visit, it was noted that warning signs had been placed at the front and back road entrances to the site, but the site remained otherwise unrestricted to public access.

Brendan Boyle and John Filpus of MDPH visited the site on November 10, 1992, meeting with MDNR, Calhoun County Health Department, EPA, and contractor personnel at the site. They toured the site on foot, walking around the perimeter inside the recently installed fence. One of the monitoring wells for the RI was being installed at the northeast corner of the site. The landfill was well vegetated. Demolition materials covered a large area in the northeast corner of the landfill proper. A steam shovel, apparently abandoned after the landfill was closed, was in a pit in the middle of the site. A concrete loading dock, constructed for the transfer station operation, was observed in the northern part of the landfill property. The proximity to the landfill of the house on the southern part of the site was noted. Boyle and Filpus also toured, by car, the Amberton Village subdivision east of the site. They noted that the westernmost row of plots in the subdivision, on the west side of Olympia Street, was not developed and covered by heavy woods, screening the landfill from the subdivision. A pile of trash was in the cul-de-sac at the south end of Olympia Street (Figure 2).

On June 12, 1997, MDCH staff talked with Kim Sakowski, the site manager for the MDEQ, to obtain information on the status of the site. She stated that other than the subsequent installation of two monitoring wells the site was in the same condition as it was when we last visited it. She said the PRPs have completed pre-design field investigations of the site and submitted the 95% design plan for the remediation of the site to the MDEQ. The PRPs expect to begin constructing a new cap for the landfill in September 1997 (14).

Other observations and information acquired during these visits are included in the appropriate sections of this assessment.

C. Demographics, Land Use, and Natural Resource Use

The ASTL site is located in the east ½ of the southeast quadrant of Section 36 of Sheridan Township (T. 2 S., R. 4 W.) in Calhoun County, Michigan. Sheridan and three other townships meet at the southeast corner of the Section, approximately 300 feet south of the southeast corner of the ASTL site. Parma Township, Jackson County, is to the east of Sheridan Township, and the eastern boundary of the site is on the boundary between Sheridan and Parma townships and between Calhoun and Jackson counties. Albion Township is south of Sheridan Township, and Concord Township in Jackson County is south of Parma Township. The populations of these four townships and of the city of Albion from the 1990 Census are listed in Table 1. Albion city limits are 1 mile west of the ASTL, and the Albion city center is approximately 1.5 miles west of the site. According to 1990 Census data, the people in Calhoun and Jackson counties were 89% white, 9.2% African-American, 0.6% Asian or Pacific Islanders, 0.5% Native American, 0.7% other race, and 1.7% of Hispanic descent. Census data indicate that 26.2% of the population of the two counties were under 18 years of age and that 12.8% were over 65 (15).

A residential subdivision, Amberton Village, is located directly east of the landfill. Land use surrounding the site is both rural residential and commercial/industrial. No land is used for agricultural purposes, and land irrigation does not occur within 3 miles of the site. The population within 1 mile of the site is approximately 1,200 people. A total of about 13,000 people within a 3-mile radius of the site use groundwater for drinking water, including some 10,000 people served by the Albion municipal water system, the residents of Amberton Village who have their own community water system, and another 2,300 people who rely on private wells for their water supply.

The service area for the Albion municipal water system includes the city and extends along Michigan Avenue east to Newburg Road (also known as 29½ Mile Road), approximately 0.5 miles west of the ASTL site. The system's source is groundwater from seven wells within the city. Three of Albion's municipal wells are located approximately 1 mile west of the ASTL site in the Clark Street Wellfield (shown in Figure 1), and four of the city's wells are located about 2.5 miles west of the site in the Brownswood and Albion Street wellfields. The Clark Street wells are completed into the Marshall Sandstone with total depths ranging from 254 to 260 feet. Two of these wells are cased to a depth of 76 feet, with the third well cased to a depth of 58 feet. The Brownswood wells are currently used to supplement other wellfields during seasonal peak demand.

The Amberton Village subdivision, east of the landfill, has its own water supply system, owned and operated by Parma Township, Jackson County. The system uses two wells located approximately 1,300 feet northeast of the center of the landfill (Figure 2). Both of these wells are completed into the Marshall Sandstone Formation at an approximate depth of 350 feet and cased to a depth of 95 feet.

The landfill owner/operator formerly occupied a residence in the southwest corner of the site and reportedly used a 108-foot-deep well for drinking water. In 1983, the landfill owner/operator sold the parcel that includes the residence (Parcel D in Figure 2), and the new owners occupy the residence. No information is available on the current status of the 108-foot-deep well (7, 16). The contractors carrying out the RI sampled a well serving this residence, citing a depth of 80 feet (3).

Another NPL site, the McGraw-Edison facility, is located 1 mile west of the ASTL site. The Brooks Foundry industrial site, the scene of an EPA emergency removal action, is approximately 0.5 mile west of the ASTL site. Both of these sites are shown in Figure 1. Approximately 30 private wells in the surrounding neighborhood were sampled in September 1989 in conjunction with the investigations of these two sites.

D. Health Outcome Data

The available information does not indicate that significant exposure to site-related contaminants has occurred at the ASTL site. As mentioned in the following section, community residents have expressed

concern about a perceived increased incidence of disease, particularly cancer, in the Amberton Village subdivision. The assessors have consulted with the Jackson and Calhoun County Health Departments about this concern.

In response to the reported community concern about cancer incidence, the assessors obtained cancer incidence data from the MDCH Office of the State Registrar and Center for Health Statistics. The evaluation of these data will be discussed in a later section of this assessment.

COMMUNITY HEALTH CONCERNS

During a telephone conversation with health assessment personnel from the Michigan Department of Community Health (MDCH) on December 9, 1992, Calhoun County Health Department personnel reported that a Calhoun County Board of Health member had mentioned that residents of the Amberton Village subdivision had expressed concerns about a high incidence of illness, especially cancer, among them and their neighbors (17). MDCH spoke with the Calhoun County Board of Health again on June 16, 1997. No additional health concerns or questions related to this site have been received since the previous inquiry.

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ENVIRONMENTAL CONTAMINANTS AND OTHER HAZARDS

Contaminants of concern at this site were selected from those chemicals for which the concentration in at least one environmental medium exceeded a health-based comparison value. Inclusion of a chemical as a contaminant of concern does not imply that human exposure to the chemical will inevitably result in health effects. The inclusion merely triggers further evaluation of the exposure to the chemical by the health assessors. Lifetime exposure to chemical concentrations at or below the appropriate comparison values for a chemical should not result in more than 1 case of cancer in 1 million people exposed or any increase in noncancer health effects. Comparison values used in this assessment include the following, developed by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Environmental Protection Agency (EPA):

ATSDR environmental media evaluation guides (EMEGs)

ATSDR cancer risk evaluation guides (CREGs)

ATSDR reference dose media evaluation guides (RMEGs), computed from the EPA reference dose (RfD) for chronic exposure of a child, assuming pica behavior for soil ingestion[4]

EPA Lifetime Health Advisories (LTHAs)

EPA Safe Drinking Water Act maximum contaminant levels (MCLs)

If no comparison values for a chemical in a medium exist, or no CREG is available for a carcinogen, the chemical is retained as a contaminant of concern. A list of the contaminants of concern for this site is given in Table 2.

To identify facilities that might contribute to the environmental contamination in the area of the Albion-Sheridan Township Landfill (ASTL) site, the Michigan Department of Public Health (MDPH) searched the Toxic Chemical Release Inventory (TRI) database for 1987 through 1992. The EPA compiles the TRI from reports provided by industries.

No entries for the ASTL were found in the TRI, either as source or as recipient of hazardous materials. The landfill closed in 1980, and the transfer station on the site closed in 1985, before the TRI started collecting data.

The TRI contained entries for five other facilities with the same postal ZIP Code (49224) as the ASTL site, including the Brooks Foundry, 0.5 mile west of the ASTL, mentioned previously under **Demographics, Land Use, and Natural Resource Use** and shown in Figure 1. The TRI entries for the Brooks Foundry were from 1987 only, and listed transport to other disposal facilities of cadmium, lead, and nickel but no environmental release of the metals. A second facility, approximately 1 mile west of the ASTL site across Clark Street from the McGraw-Edison National Priorities List (NPL) site and south of the Clark Street Wellfield (Figure 1), reported releases to the air of formaldehyde, ammonia, phenol, and ammonium sulfate solution. A third facility reported air releases of sulfuric acid from an address near the center of Albion, approximately 1.5 miles west of the site. The remaining two facilities--one reporting air and water releases of copper and manganese, air releases of methylenebis(phenylisocyanate), naphthalene, phenol, and 1,2,4-trimethylbenzene, and off-site transfers but no environmental releases of sulfuric acid, and the other reporting air releases of antimony, barium, cadmium, chromium, lead, and zinc compounds--gave addresses on the west side of Albion, 2 miles or more to the west of the ASTL site. None of the releases from any of the five facilities are likely to

contribute to environmental contamination in the vicinity of the ASTL site.

A. On-Site Contamination

For this assessment, the site is defined to be the entire original landfill property, all five parcels shown in Figure 2.

Groundwater

In 1980 and 1981, the Michigan Department of Natural Resources (MDNR) collected groundwater samples from three on-site monitoring wells that draw water from the upper aquifer--one north of the landfill, one at the southeast corner of the landfill, and one south of the landfill. These samples were found to contain elevated concentrations of iron, sodium, potassium, lead, magnesium, calcium, ammonia, total chromium, copper, and zinc (see Table 3) (18). The highest concentrations were frequently found in samples from the southeast corner well. However, later water-level measurements suggest that the groundwater in the area flows to the southwest, indicating that flow from any known waste area to this well would be across the groundwater gradient.

During the remedial investigation (RI) in 1992, the contractors constructed 13 additional monitoring wells within or along the site boundaries in 4 clusters--1 on the north end, 1 on the south end, and 2 along the west boundary. The well clusters generally included three wells, one screened in the shallow glacial aquifer, one in the upper, weathered layer of the sandstone bedrock, and one deeper within the bedrock. One cluster on the east side included four wells, one in the weathered sandstone and three deeper within the bedrock. The results of analyses of samples collected from these wells in late 1992 and early 1993 are listed in Table 4 (1, 3).

Organic chemicals were detected very rarely, and at concentrations marked as estimated because they were below the contract required detection limits. Of the chemicals listed in Table 4, a very low concentration of heptachlor was reported in a weathered bedrock well north (upgradient) of the landfill, and di-n-octyl phthalate was reported in the deeper bedrock well in the same cluster. The weathered bedrock well north of the site also contained a trace (an estimated 1 part per billion [ppb], below comparison values) of di-n-butyl phthalate, and a deeper bedrock well on the south end of the site contained a trace (1 ppb, below comparison values) of di(2-ethylhexyl)phthalate.

The EPA's RI contractors sampled the private well serving the residence on the south side of the site in October 1992. Arsenic and manganese were reported in the sample at concentrations above the comparison values (Table 5) (3). The concentrations of these metals were far below those found in monitoring wells around the landfill and were comparable to those found in off-site and upgradient residential wells.

The EPA's RI contractors also constructed three wells screened within the landfill to sample leachate, that is, water seeping through the landfilled material. When the contractors attempted to sample these wells in December 1992 and again in March 1993, only one contained any water. Concentrations of contaminants of concern found in the samples from this well are listed in Table 6 (1, 3). These samples contained low concentrations of various organic chemicals as well as elevated concentrations of various metals. Heptachlor was not detected, although heptachlor epoxide, a product of the environmental degradation of heptachlor, was reported at extremely low concentrations.

Soil

In 1992, the EPA's RI contractors collected surface soil samples at 11 locations on the site, including 6 locations on the landfill cap, 3 on the north end of the site, and 2 in the residential area in the southwest corner of the site (Parcel D). These samples included the top 6 inches of soil from the sampling locations. ATSDR prefers surface soil samples to be no more than 3 inches deep, to properly evaluate the potential hazard from contamination on the surface. The concentrations of contaminants of concern in the samples collected within the site fence are summarized in Table 7. The concentrations of contaminants of concern found in the residential area are summarized in Table 8 (3). Di-n-octyl

phthalate was found in only one sample from the residential area, and the reference indicated that the chemical was also found in a laboratory blank (quality control) sample.

Sludge and Drum Contents

Sludge samples taken in 1980 contained high concentrations of nickel, lead, cyanide, chromium, and cadmium (see Table 9) (18). During a 1989 preliminary investigation, four samples were collected of on-site barrel contents. Three of the samples had flash points of less than 75 F, falling into the category of hazardous wastes because of their ignitability. The fourth sample contained a variety of volatile organic compounds (VOCs). In addition to the identified VOCs listed in Table 9, the sample included an estimated 53 parts per million (ppm) of 23 tentatively identified VOCs, at estimated concentrations between 1 and 8 ppm (5). None of the identified chemicals exceeded available soil comparison values, although no comparison value is available for exposure to 1,1,1-trichloroethane or any of the tentatively identified chemicals through soil.

Landfill Contents

While installing the leachate wells in the landfill, the EPA's RI contractors collected samples of the material in the landfill. Concentrations found of contaminants of concern in these samples are summarized in Table 10 (3).

Air

No ambient air sampling has been performed at the site. During the field work for the RI, the contractors monitored the air in the workers' breathing space using a nonspecific organic vapor analyzer as part of their worker health and safety plan. When the borehole for a monitoring well within the landfill reached 10 feet below the surface, the analyzer indicated that more than 10,000 ppm of organic gases and vapors were in the air. The instrument indicated the vapors were above the lower explosive limit. Work on that boring was stopped for the day. The following morning, the vapors from the boring contained between 6,000 and 10,000 ppm organic vapors. The workers poured water into the boring, which helped reduce the organic vapor level in the vented gas to between 50 and 100 ppm, and work resumed. Organic vapors continued to be detected, although the concentrations decreased as the depth increased. The odor of landfill gases was noticed during installation of several subsidence monuments--structures used to monitor subsidence of the landfill cap surface--and during installation of a fence post near the northeast corner of the site.

For worker safety during the June 1994 test-pitting activities, the contractors sampled the ambient air with a photoionization detector (PID) and an airborne particle detector. The PID generally reported no organic chemicals in the air except during drum removal operations, when transient readings as high as 20 ppm were detected. The workers occasionally reported garbage odors, but not necessarily at the same times that the PID detected high concentrations. The particle detector one day detected as much as 2.67 mg/m^3 during on-site activities, though on other days it didn't exceed 0.3 mg/m^3. Workers on the site also wore organic vapor monitors, which were meant to adsorb and retain organic chemicals. After full workday exposures, none of the monitors had adsorbed any benzene, the one chemical they were analyzed for as a surrogate for all organic chemicals (19).

Biota

There is no record of any sampling or testing of consumable plants or animals that might live on the site.

B. Off-Site Contamination

Groundwater

In 1992, the EPA's RI contractors constructed 18 monitoring wells near the site. These included four three-well clusters, one to the northeast and three to the southwest; a two-well cluster, shallow glacial and deeper bedrock, to the east; and four shallow glacial wells in the wetlands south and southwest of

the site. Concentrations of contaminants of concern found in samples collected from these wells in December 1992 and March 1993 are summarized in Table 11 (1, 3).

As with the results of samples from on-site wells, organic chemicals were found very rarely in these samples and at concentrations marked as estimated because they were below the contract required detection limits. Di-n-octyl phthalate was only found off-site in samples from three upgradient wells, the glacial and deeper bedrock wells from a cluster northeast of the site and the bedrock well east of the landfill. The samples from the wells to the northeast also contained traces (estimated concentrations less than 3 ppb, below comparison values) of butyl benzyl phthalate, di-n-butyl phthalate, and diethyl phthalate, which were not found in samples from any other off-site well. These phthalates are commonly used as plasticizers, are nearly ubiquitous in the environment, and are also common laboratory or sampling contaminants. A sample from the weathered bedrock well in the same cluster contained a trace of xylenes (a total of 4 ppb [estimated], below comparison values), the only well sample to contain any xylenes.

In 1988 and 1989, the MDPH and the Calhoun County Health Department sampled 21 private wells west of the ASTL site to analyze for VOCs as part of the study of the Brooks Foundry site. At least one sample from three of the wells contained at least one VOC. A residential well approximately 0.4 mile west of the ASTL site contained 40 ppb fluorotrichloromethane (LTHA 2,000 ppb), 2 ppb 1,1-dichloroethane, and 14 ppb 1,1,1-trichloroethane (LTHA 200 ppb) in one sampling, and 15 ppb 1,1,1-trichloroethane in a second. The Brooks Foundry well contained 1 ppb 1,1,1-trichloroethane and 2 ppb fluorotrichloromethane in one sampling, but no detectable VOCs in a second. The third well, approximately 0.8 mile southwest of the ASTL site, contained 1 ppb toluene (RMEG 2,000 ppb) and was only sampled once (5). None of the VOCs were detected at levels that exceed available comparison values. No comparison values are available for 1,1-dichloroethane, but the chemical was only detected once and its presence was not confirmed by a later sampling. The detection of these chemicals in these wells is not associated with the ASTL site.

In October 1992, the EPA's RI contractors collected samples from eight residential wells near the site and one of the Amberton Village supply wells. Sampling included three of the wells sampled in 1989 that had then contained no detectable VOCs. Concentrations found of contaminants of concern are listed in Table 12 (3). The available data show no evidence of a pattern of contamination in the residential wells in the site area. No VOCs were found in any of these wells. Heptachlor was reported in samples from three wells, two approximately 0.25 mile southwest (downgradient) from the site and the Amberton Village well northeast (upgradient) from the landfill. The contractors collected duplicate samples from the Amberton Village well; one contained 0.011 ppb of heptachlor, and the other contained no heptachlor at a detection limit of 0.01 ppb. The heptachlor concentration reported from one of the downgradient wells was flagged as an estimate at 0.011 ppb, although there was no qualifier on the reported concentration from the other well (0.022 ppb). One of the downgradient wells that contained heptachlor in 1992 had also been sampled in 1989; however, the sample collected in 1989 was not analyzed for heptachlor. Three other residential wells located near the two that reportedly contained heptachlor, including one located between the two, did not contain any of the chemical at a detection limit of 0.01 ppb.

Seven of the wells contained manganese at concentrations between 61.4 and 185 ppb. Two downgradient wells, the same ones from which the samples that were reported to contain heptachlor were drawn, did not contain manganese at a detection limit of 1 ppb. Wells located north of the landfill generally contained higher concentrations of manganese (83.3 to 185 ppb) than those located southwest of the landfill (not detected at 1 ppb to 104 ppb). Two of the wells that were also sampled in 1989 did contain manganese in the 1992 sampling (83.3 ppb and 104 ppb); however, no analysis of any trend is possible since the 1989 samples were not analyzed for manganese.

In the past, two of the Clark Street wells serving the Albion municipal water supply system, approximately 1 mile west of the ASTL site (Figure 1), have contained low levels (1-2 ppb, CREG 3 ppb) of trichloroethylene (TCE), but none of the chemical has been found in either well since 1984. The Clark Street wells are approximately 1,500 feet from the McGraw-Edison NPL site, a site of soil and groundwater contamination with TCE. Since 1984, VOCs have been detected only twice in these wells:

1. Clark Street Well #1 contained 7 ppb of dichlorodifluoromethane in March 1989 (RMEG 2,000 ppb), with none detected in follow-up samples in April and May or subsequent quarterly samples.

2. Clark Street Well #3 contained 4.1 ppb of trihalomethanes (MCL 100 ppb) in one sample collected in May 1992. No organic chemicals have been found in the well in subsequent quarterly samples (20).

Another Albion municipal water supply wellfield, the Brownswood field located approximately 2.5 miles west of the ASTL site, contained traces of TCE in a 1980 sampling. The detection was not confirmed in later sampling. These wells have recently (since 1988) contained traces of methyl tert-butyl ether (maximum 18 ppb in November 1988, LTHA 40 ppb), benzene (maximum 1 ppb in November 1988, CREG 1 ppb), and toluene (maximum 1 ppb in August 1990, RMEG 2,000 ppb). The contamination has not been detected since the city stopped pumping the wells on a regular basis, only using them at high-demand periods (20). None of this contamination in the municipal wells is likely to be associated with the ASTL site. Additionally, at least three sites are known to have leaking underground gasoline storage tanks near the Brownswood and Albion Street wells. A leaking gasoline tank was removed in September 1989 from a location less than 130 feet from one of the Clark Street wells. To date, no gasoline components have been found in water samples from the Clark Street Wellfield. Because of the various contamination problems in the area, Albion's municipal wells are on a quarterly monitoring schedule for VOCs.

Because of the proximity of the Amberton Village subdivision's wells to the ASTL site, MDPH and the Jackson County Health Department have regularly sampled them and analyzed for metals and VOCs for the past 4 years. No detectable levels of organic contaminants have been found, and the metals concentrations have not been considered of health concern. The MDPH has not conducted analyses for heptachlor, reported in one 1992 EPA sample, on Amberton Village water samples (20). The heptachlor concentration reported by EPA is substantially below the level of detection used by the MDCH laboratory (0.1 ppb) (21).

Soil

The EPA's RI contractors collected surface soil samples from 6 locations outside the site, 4 approximately 1,000 feet west-southwest of the site (and upwind to the prevailing winds) to provide background data and 2 approximately 100 feet from the site boundaries, 1 southeast and 1 northwest. The concentrations of contaminants of concern in these samples are summarized in Table 13 (3). The maximum concentrations listed in the table were primarily found in the sample close to the site boundary to the northwest. The concentrations in this sample exceeded the background values, though rarely by more than a factor of 3. The concentrations of aluminum and some polycyclic aromatic hydrocarbons (PAHs) in this sample also exceeded those found in surface soil samples collected on the landfill (compare Table 7). The concentrations of PAHs found in this sample were generally comparable to those found in background agricultural soils (Reference 22, Table 5-2).

Surface Water

In October 1992, EPA's RI contractors collected water samples from six locations along the Kalamazoo River and six locations in the adjoining wetlands. These included six locations (three each in the river and wetlands) upstream of the site, with the remainder downstream of the site. Two samples, midstream and near-shore, were collected from each location on the river. Analyses of these samples found no noticeable impact on the river (Table 14) or wetlands (Table 15) that could be attributed to the site. No significant increase was found in contaminant concentrations downstream of the site compared with concentrations found upstream (3).

As indicated in the tables, each surface water sample collected was divided into two samples, and one of each pair of samples was filtered before analysis for metals, to separate dissolved metals from those in suspended solids. Chromium and zinc were detected in filtered samples from the river downstream of the site, but not in the corresponding unfiltered samples. As noted in the tables, barium (upstream and

downstream river samples), calcium (downstream river samples), magnesium, and sodium concentrations were also frequently reported to be higher in filtered samples than in unfiltered ones, though only slightly so.

Sediment

In October 1992, EPA's RI contractors collected sediment samples from six locations in the Kalamazoo River and eight locations in the adjacent wetlands. The samples were collected from the same locations as the surface water samples mentioned previously, plus two additional locations in the wetlands, one upstream and one downstream from the site. The two wetlands locations where only sediment samples were collected did not have any surface water at the time of the sampling. Two samples, midstream and near-shore, were collected from each location on the river. Analyses of these samples did not show any significant impact from the site on the river (Table 16) or wetlands (Table 17). Chemical concentrations in downstream samples were not significantly increased compared with those in upstream samples (3).

Biota

There is no record of sampling and analysis of biological materials from areas near the site for evidence of site-related contaminants.

In July 1987, MDNR collected fish from several places along the Kalamazoo River to analyze for polychlorinated biphenyls (PCBs) as part of its investigation of PCB contamination of the river. The collection site closest to the ASTL site was in the Ceresco Impoundment, approximately 20 miles downstream from the ASTL site. There, MDNR collected and analyzed 9 carp (lengths between 17.3 inches and 25.6 inches), one largemouth bass (14.4 inches), and one smallmouth bass (15 inches). The highest PCB concentration found was in one of the carp, 0.24 ppm in a skin-off fillet sample. The largemouth bass collected contained 0.02 ppm, the smallmouth 0.04 ppm, both in skin-on fillet samples (23). The PCB concentrations found in these fish are commonly found in fish from Michigan waters, even in areas with no known PCB source. It is highly unlikely, given the distance from the site the fish were collected, that the PCBs detected in the fish are related to the ASTL site.

C. Quality Assurance and Quality Control

In preparing this public health assessment, the Michigan Department of Community Health (MDCH) relied on the information provided in the referenced documents and assumed that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and conclusions drawn for this health assessment is determined by the reliability of the referenced information. Any qualifications noted in the sources for the data cited for this assessment are discussed with the data.

Much of the environmental data, marked J in the tables, was noted in the sources as estimates, most commonly reflecting a value reported below the contract required detection limit for the analytical technique, but above the detection limit of the instrument used. These results indicate that the chemicals were present in the samples, but the reported values should only be considered to be estimates.

Chromium and zinc were detected in filtered water samples from the Kalamazoo River downstream of the site, but were not detected in the corresponding unfiltered samples. Other filtered surface water samples contained concentrations of metals slightly higher than those in the corresponding unfiltered samples. These findings are therefore questionable, and may be the result of laboratory error or artifacts from the filtration technique used.

The heptachlor detections in the samples from residential wells have been brought into question, because follow-up samples have not been taken to confirm the chemical's presence. Of the three samples from the residential wells with positive detections of heptachlor, one (0.011 ppb) was flagged as estimated and a second (also 0.011 ppb) was a duplicate sample of one in which no heptachlor was detected (detection limit 0.01 ppb). It is also unusual to find heptachlor as the only organic contaminant in such a situation, and no heptachlor epoxide, a common environmental decomposition product (24). In addition,

the heptachlor detection limit of 0.01 ppb cited in the RI report might be too low to be reliable. One EPA contract laboratory managed to attain that precision in tests of the detection methods, but the overall average method detection limit (MDL) among all the laboratories consulted was 0.04 ppb. EPA adopted an upper control limit to the MDL of 0.088 ppb. The heptachlor levels reported in the RI investigation were substantially below these MDL values. MDCH laboratory personnel use a detection limit for heptachlor in water of 0.1 ppb, 10 times the detection limit cited in the RI report and 5 times the maximum concentration detected in the water supplies (21).

D. Physical and Other Hazards

Until the site was fenced in the summer of 1992, public access to the site was not restricted. In a February 1989 site visit by MDPH, footprints and snowmobile tracks were observed leading onto the site. During the fall 1989 visits, considerable evidence of hunting and target practice was noted in the form of spent shells on the ground surface. During the removal action in the summer of 1990, which also included installation of gates and fences at several entrances to the site, personnel for the contractor supervising the action for EPA found that one of the fences had been cut and a lock from one of the gates had been vandalized and removed. Fresh all-terrain vehicle tracks were present near the cut in the fence. The fence was then repaired and the lock replaced (6). Most of the site was fenced as part of the RI field work in the fall of 1992.

On-site physical hazards include a deep borrow pit in the northwest quadrant of the site and partially buried scrap metal littered around the uneven terrain. A large pile of construction debris was seen in the north end of the site during the MDPH 1992 site visit.

Anaerobic decomposition of organic material can produce methane gas. Excavations into the landfill resulted in the release of organic vapors at potentially explosive concentrations. These landfill gases could pose some threat of fire or explosion if they should collect in sufficient concentration. The chance of this happening at this site is reduced by the current porous sand and gravel cover over the landfill. Any gases generated in the wastes are likely to diffuse quickly through the cover to the surface and disperse in the atmosphere. However, persons excavating the landfill may encounter high concentrations of flammable gas, risking fire or explosion unless appropriate precautions are taken.

The drummed waste found on the site in 1989 included material with a flash point below 75 F, which would lead regulatory agencies to classify the material as ignitable. Some drums were removed from the site in the summer of 1990, but the MDNR found 200 to 400 drums buried on the site in June 1994 (4). Any drums that contain wastes similar to those found in 1989 may pose a fire hazard.

PATHWAYS ANALYSES

To determine whether nearby residents are exposed to contaminants migrating from the site, the Agency for Toxic Substances and Disease Registry evaluates the environmental and human components that lead to human exposure. An exposure pathway contains five major elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population.

An exposure pathway is considered a completed pathway if there is evidence that all five of these elements are present or have in the past been present. An exposure pathway is considered a potential exposure pathway if one or more of these elements are missing; that is, at least one of the five elements is missing. An exposure pathway can be eliminated from consideration if one of the elements is not present and could never be present. The most important exposure pathways at this site are discussed in the following sections.

A. Completed Exposure Pathways

Surface Soil

Surface soil on the site contains various contaminants at levels potentially of human health concern.

People on the site can come into contact with this soil and absorb contaminants through their skin. A person can also incidentally ingest soil that adheres to his or her hands. Soil can be picked up by the wind or kicked up by a vehicle as dust, which a person on the site can then inhale. There were signs of traffic on the site, all-terrain vehicles, before the site was fenced in 1992. The new fence should deter further traffic on the site. In 1984, Michigan Department of Natural Resources (MDNR) personnel inspected the landfill cover, saw no evidence of direct contact hazard, and concluded the site did not require fencing (25). At that time, the Michigan Department of Public Health (MDPH) agreed with their decision (26). During the fall 1989 site investigations, leaking drums were discovered on the site and preliminary testing indicated the drums contained ignitable hazardous wastes and volatile organic compounds (5). These drums did pose a direct contact and fire hazard. The most accessible drums were removed for off-site disposal in 1990. Three adults living in the residence on the south end of the site still have access to their parcel of the site property, although a fence now blocks their access to the bulk of the landfill. From the available information, the number of people who might have had access to the landfill cannot be estimated.

Surface soil samples collected near the site contained metals and polycyclic aromatic hydrocarbons at concentrations potentially of human health concern. The limited data available do not indicate the source of these contaminants, and the concentrations found are generally comparable to background levels. Access to the area is not restricted, and signs of use have been seen. The area where the highest concentrations of chemicals were found in off-site soil samples is near a point where access to the landfill itself occurred in the past. With the available information, the number of people who might have been exposed in this manner cannot be determined.

Kalamazoo River

Contaminants originating on the site can reach the Kalamazoo River and its associated wetlands via discharge of contaminated groundwater or surface runoff. Once in the river and wetlands, the contaminants will partition into the water, sediment, and air, and river or wetland biota may accumulate some of the contaminants. People using the river for recreation could be exposed to the contaminants by direct contact with water or sediments, incidental ingestion of water or sediments, or consumption of biota, especially fish, taken from the river. The river is extensively used for recreation, including swimming, fishing, and boating. There is no record of any municipal or private water supply using water from the river. Analysis of water and sediment from the river and wetlands near the site does not show any discernible contamination attributable to the site. The nearest place to the site along the river where biota have been sampled for analysis was Ceresco, 20 miles downstream. Low concentrations of polychlorinated biphenyls (PCBs) were detected in fish collected at Ceresco, but there is no indication that the PCBs at that point are related to the Albion-Sheridan Township Landfill site.

B. Potential Exposure Pathways

Groundwater

Rainwater can filter through the landfill cover and into the wastes below. In the wastes, the water can dissolve chemicals from the waste materials, then filter through the soil below the landfill into groundwater aquifers. Contamination with various metals in the groundwater at and near the site has been documented. Organic chemicals in the wastes have been found in leachate samples, but have not been reliably found in deeper or off-site groundwater.

The chemicals could move with the groundwater and reach residential or municipal wells. People using these wells for their household water supply can be exposed to chemicals in the water through ingestion, dermal contact, or inhalation of volatile chemicals secondary to household use.

The existing off-site private wells downgradient of the site are sufficiently far from the site that any groundwater carrying contamination from the site would probably discharge to the Kalamazoo River long before it would reach the wells. The well serving the residence on the south end of the site does not appear to be affected by contamination from the site (compare Table 5 with Tables 3, 4, 11, and 12). Future development of the area immediately southwest of the site might include wells for residential use

drilled into the contaminant plume. That potential residents would drill such wells, totally disregarding the situation in the vicinity of their property, seems highly unlikely.

Arsenic has been reported in water from residential wells near the site at concentrations estimated to range from 1.1 to 1.7 ppb. Arsenic, however, is a naturally occurring element that is frequently found at much higher levels than those found in Michigan groundwater, particularly in association with the Marshall Sandstone Formation, which forms the upper bedrock in the vicinity of this site. MDPH sampling of 250 water supply wells in Calhoun and Jackson counties has shown a range of arsenic concentrations from none detected to 22 ppb, with an average of 1.6 ppb. Concentrations of arsenic vary widely based on depth of the well and length of time the well is pumped before sampling. Higher levels of arsenic were found in some monitoring wells on or near the site (up to an estimated 126 ppb) than in residential wells. The concentrations found in the residential wells are probably not site-related because upgradient wells contained concentrations comparable to those downgradient of the site. Arsenic concentrations in private wells are far below the current maximum contaminant level (MCL) of 50 ppb.

Heptachlor was tentatively identified in three residential wells and one upgradient on-site monitoring well but was not detected in leachate samples collected within the landfill. Maximum levels reported in residential well samples were 20 times lower than the EPA MCL (0.4 ppb) for drinking water and far below the limit of detection for most analytical laboratories.

Manganese was reported in landfill leachate samples (832 ppb), upgradient monitoring wells (maximum of 363 ppb), downgradient monitoring wells (maximum of 411 ppb), and in residential wells (maximum of 63 ppb in the on-site residence and 185 ppb in off-site residential wells). Like arsenic, manganese is a naturally occurring element and concentrations will vary by depth and geographic region. Because similar concentrations of manganese were found in upgradient and downgradient samples, it is unlikely that the concentrations of the metal reported in residential wells were related to the site.

Samples from every residential well sampled for the remedial investigation were reported to contain either arsenic, heptachlor, or manganese at concentrations that exceeded a comparison value. The total population using these wells is approximately 200 persons. The potential health effects from exposure to these chemicals through the drinking water are explored in the following section.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

The only known completed pathway for human exposure to contaminants from the Albion-Sheridan Township Landfill (ASTL) site is for a person coming onto the site and coming into direct contact with contaminated surface materials. Current and future access by unauthorized personnel to the landfill itself is strongly deterred by the site fence. Access would have been more frequent before the site fence was installed, although it would probably not have been very common. The occupants of the residence on the south end of the site have had regular and frequent access to their parcel of the property. It is not known how frequently they went onto the landfill proper before the fence was installed. Surface soil samples collected near the landfill contained concentrations of polycyclic aromatic hydrocarbons (PAHs) and metals potentially of human health concern, but not significantly above background levels. People who visit the site vicinity are therefore not likely to incur a significantly increased health risk.

This evaluation covers two exposed populations: residents of the house on the south end of the property and trespassers onto the landfill proper.

In addition, people living near the site and using private wells for their water supply might be exposed to arsenic, heptachlor, and manganese at concentrations above comparison values; however, the presence of heptachlor was not confirmed, and the presence of any of these chemicals in the residential wells may not be related to the ASTL site. Aluminum, calcium, iron, magnesium, potassium, and sodium were also detected in the residential well samples, but no comparison values are available for these metals. The detection of these metals in samples from the private wells may not be related to the ASTL site.

The exposure doses for the on-site residents are calculated using the following assumptions (27):

Adult:	
Weight:	70 kg
Water consumption:	2 L/day
Soil ingestion (incidental):	100 mg/day
Infant:	
Weight:	10 kg
Water consumption:	1 L/day
Soil ingestion (incidental):	200 mg/day
(pica behavior):	5,000 mg/day

As a conservative assumption, we assumed that the soil containing the highest contaminant concentrations to which on-site residents are exposed is the soil around the residence on the site (Table 8). Their primary water supply is their well, with composition assumed to be that found in the remedial investigation (RI) sampling (Table 5). No children currently live in the residence on the site; however, children subject to pica behavior were included in this evaluation to address the

Trespassers on the landfill would probably not include very young children, those subject to pica behavior. Trespassers would also not be likely to visit the site more than 2 days a week. We assume, to be conservative, that trespassers encounter soil containing the highest concentrations of contaminants found in surface soil samples from the landfill (Table 7).

The primary benchmarks against which exposures are evaluated for their potential for causing noncancer adverse health effects are the minimal risk levels (MRLs), developed by the Agency for Toxic Substances and Disease Registry (ATSDR), and reference doses (RfDs) and reference concentrations (RfCs), developed by the Environmental Protection Agency (EPA). It is generally accepted that a person exposed to a dose of a chemical less than an MRL, RfD, or RfC is not likely to experience noncancer adverse health effects. The derivation of MRLs, RfDs, and RfCs from the observed threshold exposures includes safety factors to allow for different responses between species and between individuals. However, these values may not be protective for individuals who are hypersensitive to chemical exposures, including the very young, the very old, individuals whose bodies are under stress from illness, and individuals who have an allergic response to the chemical.

Threshold exposures from which MRLs, RfDs, and RfCs are derived may also be cited if none of the derived values are available. The threshold exposures include lowest-observed-adverse-effect levels (LOAELs) and no-observed-adverse-effect levels (NOAELs). In a given experiment, with exposure route, species, and health effect specified, the LOAEL is the lowest exposure at which the effect was observed, and the NOAEL is the highest exposure at which no effect was observed.

For chemicals that may cause cancer, the risk associated with an exposure is evaluated separately from noncancer health risks, using published potency factors, which relate the chance of contracting cancer to the dose of the chemical. For this assessment, the risk of cancer is considered significant if 1 extra case of cancer is likely to develop among 1 million people subject to the exposure over their lifetimes.

Metals

Aluminum

No MRLs or RfDs are available for exposure to aluminum. Most aluminum compounds are considered virtually nontoxic. Patients suffering from Alzheimer's disease sometimes have abnormally high

concentrations of aluminum in their brains, but whether the aluminum causes the disease is not known. Patients suffering from renal failure who were treated with aluminum-containing compounds accumulated the metal in their brains and bones, experiencing dementia and bone diseases. The dementia in these cases does not include other indicators of Alzheimer's disease. Rats who were fed aluminum-containing compounds had smaller offspring. Consumption of water containing the aluminum concentrations found on and near the site would not be likely to result in a dose of aluminum equaling the LOAEL. No one, not even a child prone to pica behavior, is likely to ingest enough soil or sediment containing the aluminum concentrations found on or near the site to attain the LOAEL. No available evidence links aluminum exposure to cancer. EPA has proposed a secondary maximum contaminant level (SMCL), based on non-health-related criteria such as color, odor, and taste, for aluminum of 50 ppb (28). One of the samples from an upgradient residential well exceeded this level.

Arsenic

The concentrations of arsenic found in surface soil on and near the ASTL site are within the range of concentrations found in the eastern United States (27). The concentrations in the surface soil, including the background samples (3.9-6.5 ppm), were at or above the high end of the range of concentrations found in sandy topsoil[5] in that area of Michigan (29). The concentrations of arsenic reported in water samples from residential wells were substantially below the EPA maximum contaminant level (MCL) for the metal (50 ppb) and were within the range commonly found in groundwater. A child subject to pica who plays regularly in soil containing the concentration of arsenic found around the residence on the site might ingest enough arsenic from the soil to exceed the MRL for noncancer adverse health effects. No one else is likely to incidentally ingest enough arsenic from the soil near the residence or to ingest enough of the metal from the water in the well to exceed the MRL. The combined dose through incidental ingestion and water consumption is not likely to exceed the MRL. The estimated exposure dose for a child with pica from ingestion of the soil would not be likely to exceed the dose at which hardening and changes in color of the skin have been observed (the LOAEL), although the exposure dose might exceed the highest dose at which no adverse health effects were observed. The combined arsenic dose from pica consumption of soil and regular consumption of water from the well would not be likely to exceed the LOAEL. Ingestion of arsenic has also been linked to cancer of the skin, bladder, liver, kidney, and lungs in epidemiologic studies. EPA has classified arsenic as a known human carcinogen (EPA Class A) (30). Lifetime consumption of water containing the concentrations of arsenic reported in samples from residential wells on and near the site may result in a low increased risk of contracting skin cancer. A person who lives in an area with soil containing the concentrations of arsenic found in the soil in the site vicinity may incidentally ingest enough of the metal to also incur a low increased risk of contracting skin cancer. The combined dose from incidental ingestion of soil and consumption of groundwater is likely to result in a low increased risk of contracting skin cancer. Available information is insufficient to estimate the risk of contracting other cancers through ingestion of arsenic.

Barium

No one would be likely to ingest enough barium from the soil around the residence on the site or the water in the well supplying the residence or both sources combined to exceed the RfD. No one is likely to incidentally ingest enough soil from the site to attain a dose of the metal that would approach the RfD. No MRLs are available for barium. No available evidence links barium exposure to cancer (31).

Cadmium

No one who is likely to have access to the site or the sediments of the Kalamazoo River is likely to incidentally ingest enough cadmium to attain the MRL or RfD for noncancer adverse health effects. The evidence linking occupational inhalation of cadmium compounds to increased incidence of lung cancer is weak. Some laboratory animals who breathed cadmium compounds developed lung cancer. EPA has classified cadmium compounds by inhalation as probable human carcinogens (EPA Class B1). Available information is insufficient to determine whether cadmium and its compounds are carcinogenic when ingested (32).

Chromium

Chromium is rarely found in the environment as the pure metal, but rather combined with other elements in chemical compounds. Chromium combines with other elements primarily in one of two oxidation or valence states, trivalent or chromium(III) and hexavalent or chromium(VI). The toxicity of a chromium compound is very dependent on the valence state of the chromium included. Chromium(III) compounds are considered virtually nontoxic, and chromium(III) is an essential trace element in the diet. Chromium(VI) compounds can irritate the skin and gastrointestinal tract, and can cause liver damage. Inhalation of chromium(VI) compounds has been linked to cancer of the lung and respiratory tract in industrial workers and laboratory animals. EPA has classified chromium(VI) as a human carcinogen by inhalation (EPA Class A). Not enough information is available to assess the carcinogenicity of chromium(VI) by any other exposure route or of chromium(III) by any route of exposure. The available data on the environmental media at the site reports the total chromium concentration, without distinguishing between the valence states. Chromium(VI) tends to be reduced to chromium(III) by naturally occurring chemical reactions in the environment. No one likely to have access to the site is likely to ingest enough chromium from the soil to exceed any chromium RfD. ATSDR has not issued any MRLs for chromium. No one would be likely to ingest enough of the metal from the soil around the residence on the site to attain the RfD for chromium(VI). A child with pica living in the residence might ingest enough chromium from both the soil and the water supply to attain the RfD for chromium(VI), if the chromium concentration in the water (reported as not detected at a detection limit of 10 ppb) is a substantial fraction of the detection limit. The estimated dose would not be more than 15% above the RfD, substantially below any available LOAEL (for enhancement of dermatitis in chromium-sensitive individuals). Available information is insufficient to evaluate the risk of cancer from the chromium at the site (33).

Cobalt

No MRLs or RfDs are available for cobalt. No one is likely to ingest sufficient cobalt from the soil, sediments, groundwater, or surface water at or near the site to attain the LOAEL listed in the toxicological profile for the metal (34). Cobalt sulfate was once added to beer to stabilize the foam, and some heavy beer drinkers developed serious to fatal heart problems. Other factors may have contributed to their heart conditions. No corresponding NOAEL was reported. A child with pica playing in the soil around the on-site residence might experience an exposure dose approximately one-twentieth of the LOAEL, and trespassers in the site vicinity would experience lower doses. No available evidence links ingestion, inhalation, or dermal exposures to cobalt compounds with cancer. Some laboratory animals developed cancer when cobalt compounds were injected into their bodies. The International Agency for Research on Cancer (IARC) has classified cobalt and cobalt-containing compounds as possible human carcinogens (IARC Class 2B). EPA has not classified cobalt and its compounds for carcinogenicity. Available information is not sufficient to evaluate the cancer risk, if any, from exposure to cobalt at this site (34).

Copper

No MRLs or RfDs are available for exposure to copper. No one is likely to ingest enough copper from soil, groundwater, surface water, or sediment on or near the site to attain the LOAEL reported in the toxicological profile for the metal, for gastric distress including vomiting and diarrhea after ingestion of large quantities of copper in food or water. No NOAEL was reported in these incidents. A child with pica playing in soil containing the concentration of copper found near the on-site residence might experience an exposure dose approximately one-tenth of the LOAEL. No evidence links exposure to copper with cancer in humans or animals. Both EPA and IARC have determined that copper is not classifiable as to its carcinogenicity (EPA Class D, IARC Class 3) (35).

Lead

No MRLs or RfDs are available for exposure to lead. Lead tends to accumulate in the body, and the health effects of any exposure to the metal depend on the subject's previous history of exposure. No one is likely to ingest enough lead from the soils around the on-site residence to attain the LOAEL listed in

the toxicological profile for the metal, for changes in the levels of certain enzymes in the blood on intermediate-term exposure. The enzymes that were tracked are involved in the synthesis of hemoglobin. No one is likely to incidentally ingest enough soil from on or near the site to experience a lead dose in excess of the LOAEL. No NOAEL was cited, and because lead accumulates in the body, a long exposure to a low dose may have the same effect as a short exposure to a high dose. Lead can also interfere with the development of the nervous system in fetuses and children. Some experimental animals fed food containing lead developed cancer of the kidneys. EPA has classified lead as a probable human carcinogen (EPA Class B2). Available information is insufficient to evaluate the risk of contracting cancer from exposure to lead at this site (36). The lead concentration in the soil around the residence is much lower than that commonly found in urban areas and is not generally considered to be of health concern.

Manganese

A child whose primary drinking water supply contained the manganese concentration found in the residential well on the site or in most of the residential wells near the site might ingest enough of the metal to exceed the RfD through ingestion of water.[6] ATSDR has not issued any MRLs for manganese. No one is likely to ingest enough soil from the area of the residence to exceed the RfD for manganese through ingestion of soil. No adult is likely to incidentally ingest enough soil or sediment from anywhere on or near the site to exceed the RfD for manganese. A child with pica who visits the site area 2 days a week might ingest enough manganese from the soil to exceed the RfD, though not to exceed the LOAEL for mild neurological effects seen in a study of people whose drinking water contained high levels of manganese. No available evidence links exposure to manganese with cancer (37, 38). EPA has not issued an MCL for manganese in drinking water under the Safe Drinking Water Act. EPA has issued an SMCL for manganese of 50 ppb, equal to the reference dose media evaluation guide (RMEG). Water samples from residential wells near the site do exceed this SMCL.

Nickel

No MRLs are available for ingestion of nickel and its compounds. EPA has issued an RfD for ingestion of soluble nickel compounds, but not for other nickel compounds. No one is likely to ingest enough nickel from the soils on or near the site to exceed the RfD for soluble compounds or the NOAEL for a transient impairment of vision reported after a single exposure to nickel sulfate in an experiment using human volunteer subjects. A small fraction of the population is allergic to nickel, and once these persons are sensitized by exposure to the metal, they can suffer dermatitis after further contact or ingestion. Inhalation of water-soluble nickel compounds or of nickel subsulfide (Ni_3S_2) has been linked to cancer in nickel plant workers and laboratory animals. No evidence links ingestion of nickel compounds with cancer. EPA has classified nickel refinery dust and nickel subsulfide as human carcinogens (EPA Class A), but has not classified other nickel compounds. IARC has classified all nickel compounds as human carcinogens (IARC Class 1), and metallic nickel as a possible human carcinogen (IARC Class 2B) (39). Available information is not sufficient to evaluate the risk of cancer due to exposure to nickel at this site.

Vanadium

An MRL has been derived for intermediate-term exposure (between 14 days and 1-year duration) to vanadium by ingestion, but not for chronic exposure, and no RfDs are available for the metal. A child subject to pica who plays in soil containing the concentration of vanadium found in the soil around the on-site residence might ingest enough of the metal to exceed the intermediate-term MRL. No one else is likely to incidentally ingest enough of the soil to exceed the intermediate-term MRL. The child with pica is not likely to ingest enough vanadium to attain the NOAEL (from an experiment on rats) that the MRL was derived from, or a higher NOAEL from a study on human exposure. No evidence links exposure to vanadium to cancer (40). Health effects from the vanadium at or around the ASTL site are not likely.

Other Metals

Calcium, iron, magnesium, potassium, and sodium commonly occur in soil, groundwater, and surface

water in the environment at concentrations similar to those found at and near the site. There are no health-based standards for these metals in environmental media. EPA has issued an SMCL for iron of 300 ppb in drinking water, and none of the residential well samples exceeded this level. Individuals who have received medical advice to restrict their sodium intake might be advised not to consume water containing more than 200 ppm of sodium. None of the residential well samples exceeded this level.

Organic Chemicals

Di-n-octyl phthalate

Little information is available on the toxic effects of exposure to di-n-octyl phthalate (DNOP). One report describes a worker in an imitation leather plant who developed an asthmatic reaction to the chemical after continuous occupational exposure (41). Laboratory animals fed food containing the chemical developed enlarged livers, although no indications of changes in the organ's function were reported. DNOP has generally been found to be less toxic than the related compound bis(2-ethylhexyl)phthalate (BEHP). The exposure dose of DNOP experienced by anyone from the soil and water on or near the site is not likely to equal the MRL for BEHP and, therefore, is not likely to result in any adverse noncancer health effects. No evidence is available that exposure to DNOP causes cancer; however, one experiment with laboratory animals indicates that ingestion of DNOP can increase the carcinogenic effects of other chemicals (42, 43).

Heptachlor

Although there are no MRLs or RfDs for heptachlor, EPA has issued an MCL of 0.4 ppb, with a maximum contaminant level goal of 0. As mentioned previously in the **Quality Assurance and Quality Control** section, the concentrations of heptachlor reportedly found in water samples from the residential wells near the site were below detection limits that are considered reliable. The following discussion takes the conservative position that the reported concentrations of heptachlor in samples from the residential wells were real detections and accurately measured. The estimated exposure dose experienced by a child whose primary drinking water supply is one of the residential wells near the site that tentatively contained heptachlor would be approximately a factor of 100,000 below the LOAELs identified in animal studies. No NOAEL was reported in the study with the lowest LOAEL, for reproductive failure in rats. Some laboratory animals fed heptachlor developed liver cancer. EPA has classified heptachlor as a probable human carcinogen (EPA Class B2) (24). Lifetime consumption of water containing the concentration of heptachlor tentatively identified in samples from residential wells near the site would result in no apparent increased risk of contracting cancer. The heptachlor concentration reported in samples from the residential wells is approximately one-twentieth of the MCL.

Polychlorinated Biphenyls (PCBs)

No one who is likely to be on the site is likely to incidentally ingest high enough concentrations of PCBs from the soil or the wastes in the landfill to exceed the MRL for noncancer adverse health effects. Laboratory animals that ingested PCBs suffered liver cancer. EPA has classified all PCBs as probable human carcinogens (EPA Class B2) (44). Lifetime exposure to and incidental ingestion of soil containing the concentrations of PCBs found in surface soil or wastes at the site could result in a low increased risk of cancer. A typical trespasser on the site would incur no apparent increased risk of cancer, since he or she would probably not spend much time on the site.

A person who consumes the average U.S. consumption rate for fish of 12 g/day (Reference 27, Table E.1) of fish containing the maximum concentrations of PCBs found in the carp collected from the Ceresco Impoundment would ingest a dose of PCBs above the MRL, though less than the LOAEL. Such a fish consumer might also incur a low increased risk of contracting cancer from the PCBs in the fish. The Michigan Department of Community Health (MDCH) uses the Food and Drug Administration's action level for PCBs in fish, 2 ppm, as a trigger level for implementing fish consumption advisories (45). None of the sampled fish contained PCBs at or above the trigger level; therefore, the MDCH has not issued any fish consumption advisory for the Kalamazoo River above Battle Creek, 30 miles downstream from the ASTL site (46).

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs found on or near the ASTL site include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, and phenanthrene. No MRLs or RfDs have been established for any of these chemicals. It is highly unlikely that anyone would ingest enough soil from the site to attain a dose of any of these chemicals equal to the LOAELs or NOAELs for noncancer health effects determined in laboratory experiments or health studies. Exposure to benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene is linked to cancer in experimental animals. EPA has classified these PAHs as probable human carcinogens (EPA Class B2). EPA has classified the other PAHs found at the site as not classifiable with regard to carcinogenicity (EPA Class D) (22, 47). Benzo(a)pyrene is the most potent of the carcinogenic PAHs found in the surface soil around the residence on the site, according to published relative potency values (48). Estimates of the risk based on these relative potency values indicate that no one is likely to ingest high enough concentrations of] PAHs from the soil from the area around the residence to incur any apparent increased risk of contracting cancer. Someone who spends his or her entire life around soil containing the concentrations of carcinogenic PAHs found on the landfill or in adjacent areas might incidentally ingest enough of the chemicals to incur an increased risk of cancer slightly above the level of significance; however, no one is likely to spend enough time in the vicinity of the landfill to ingest enough soil to incur a significantly increased cancer risk.

B. Health Outcome Data Evaluation

The MDCH Office of the State Registrar and Center for Health Statistics provided the assessors with cancer incidence data for ZIP Code 49224 for the years 1985 through 1991. The ZIP Code area includes the ASTL site, the city of Albion, Amberton Village subdivision, and surrounding areas in both Calhoun and Jackson counties. Comparing the incidence data from the area with estimates computed using data from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program[7] shows that the cancer incidence in the area has been lower than the national rates (Table 18) (50). This indicates that there is no increased incidence of cancer in the ZIP Code area around the site, although the data are not sufficient to permit detection of possible localized clusters.

C. Community Health Concerns Evaluation

Environmental health personnel from the Jackson County Health Department investigated the reports of an excessive incidence of cancer and other illness in the Amberton Village subdivision. They interviewed the Calhoun County Board of Health member who reported the concerns and personnel from the Michigan Department of Natural Resources, Michigan Department of Public Health, and EPA, and did not find any evidence to suggest an environmental cause for the reported cancer or illness incidence (51). MDCH staff have also contacted the Board of Health member, but he could not provide sufficient information for further investigation of the concerns. As mentioned in the preceding section, cancer incidence data from the MDCH Office of the State Registrar and Center for Health Statistics do not indicate any increased incidence of cancer in the ZIP Code area around the site (50).

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PUBLIC HEALTH ASSESSMENT

ALBION-SHERIDAN TOWNSHIP LANDFILL
SHERIDAN TOWNSHIP, CALHOUN COUNTY, MICHIGAN

CONCLUSIONS

1. On the basis of information reviewed, the Albion-Sheridan Township Landfill (ASTL) site does not pose any apparent public health hazard under current conditions. The site did pose a public health hazard in the past and may pose one in the future because of possible exposure to hazardous substances at concentrations that may result in adverse health effects. As noted previously in the **Environmental Contaminants and Other Hazards**, **Pathways Analyses**, and **Public Health Implications** sections, humans may have been exposed to various metals in the past through incidental ingestion of soils on the landfill. Access to the site has probably been infrequent, and the site has recently been fenced to deter future access. In addition, a child subject to pica behavior might ingest enough of various metals from the soil around a residence on former landfill property south of the landfill itself to incur a slight risk of adverse health effects. No children are currently living in this residence, though future inhabitants may include children.

2. A plume contaminated with arsenic, manganese, and other metals is in the groundwater beneath and downgradient of the landfill. However, this plume apparently has not reached any existing private wells in the area, including one directly south of the landfill. Organic chemicals have been found in leachate within the landfill, though no confirmed organic contamination has been reported in the groundwater below the landfill.

3. Arsenic, heptachlor, and manganese have been detected at concentrations of human health concern in water from residential wells in the site area. The presence of these chemicals in the private wells near the site is probably not caused by conditions on the site, since the concentrations detected are the same in wells upgradient of the ASTL site as in downgradient wells. None of the reported concentrations of these chemicals exceed the Environmental Protection Agency's maximum contaminant limits, and the validity of the reported concentrations of heptachlor has been questioned. The potential adverse health effects from exposure to water containing the reported heptachlor concentrations would be minor.

4. Cancer incidence data kept by the Michigan Department of Public Health were examined in response to reports of concern about cancer incidence in a nearby community. The data do not indicate any increased incidence of cancer in the ZIP Code area including the site.

RECOMMENDATIONS

1. The remediation option selected for this site should provide for the control of off-site migration of contaminants. The Michigan Department of Community Health (MDCH) supports the Environmental Protection Agency's (EPA) decision to cap the landfill as prescribed in its record of decision (ROD) (12). MDCH understands that EPA and the owners of the residence south of the landfill are negotiating to include that portion of the former landfill property in the remediation.

2. The monitoring wells on and near the site should be sampled on a regular basis to detect migration of the contaminant plume. In addition to sampling for the metals found in the plume to monitor its location, samples should be periodically analyzed for EPA's Target Contaminant List of organic chemicals to determine whether the leachate from the landfill is reaching the groundwater aquifers. The EPA ROD includes monitoring of the groundwater for 5 years to determine whether further treatment is required (12).

3. Future remedial investigations (RIs) or remedial activities include periodic sampling of private and municipal wells in the vicinity of the site. These wells should be sampled at least once each

year for arsenic and manganese. The wells in which heptachlor was reported should be sampled again to confirm the presence of the chemical. Because of the questions about the validity of the data and the detection limits previously mentioned in the **Quality Assurance and Quality Control** section, the laboratory that performs the analysis must have the capability to accurately measure this compound in the range of concentrations originally reported by the EPA contractor laboratory used for the RI. The EPA ROD for the site includes monitoring of nearby residential wells (12).

HEALTH ACTIVITIES RECOMMENDATION PANEL STATEMENT

A Health Activities Recommendation Panel convened by the Agency for Toxic Substances and Disease Registry (ATSDR) and MDCH has evaluated the data and information developed for the *Public Health Assessment for the Albion-Sheridan Township Landfill* to ascertain appropriate follow-up health actions. The panel determined that there is circumstantial evidence that trespassers on the site may have been exposed to environmental contaminants. However, there is no evidence that this exposure was of significant human health hazard. The community around the site has expressed concern about the perceived incidence of cancer in their community, and a program of citizen and physician education should be developed to address these concerns.

PUBLIC HEALTH ACTIONS

Public health action plans (PHAPs) are developed to describe actions to be taken by ATSDR or MDCH, or both, at and in the vicinity of sites after public health assessments are completed. The purpose of the PHAP is to ensure that public health assessments not only identify public health hazards, but also provide a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions undertaken and to be implemented by ATSDR or MDCH, or both, are as follows:

Health Actions Undertaken

The Michigan Department of Public Health (MDPH) referred a report of concerns about increased cancer incidence in a community near the site to the Jackson County Health Department. The Jackson County Health Department, in cooperation with the MDPH, conducted a preliminary investigation of the concerns.

Health Actions Planned

MDCH, ATSDR, the Jackson County Health Department, and the Calhoun County Health Department will develop a program of health education to address the health concerns of the residents of the site area.

ATSDR and MDCH will coordinate with federal and state environmental agencies to carry out the other recommendations made in this assessment.

ATSDR will reevaluate and expand the PHAP when needed. New environmental, toxicological, or health outcome data, or the results of implementing the above proposed actions and recommendations may determine the need for additional actions at this site.

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CERTIFICATION

The Albion-Sheridan Township Landfill Area Public Health Assessment was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was initiated.

William Greim
Technical Project Officer, SPS, SSAB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with its findings.

Richard Gillig
for Director, DHAC, ATSDR

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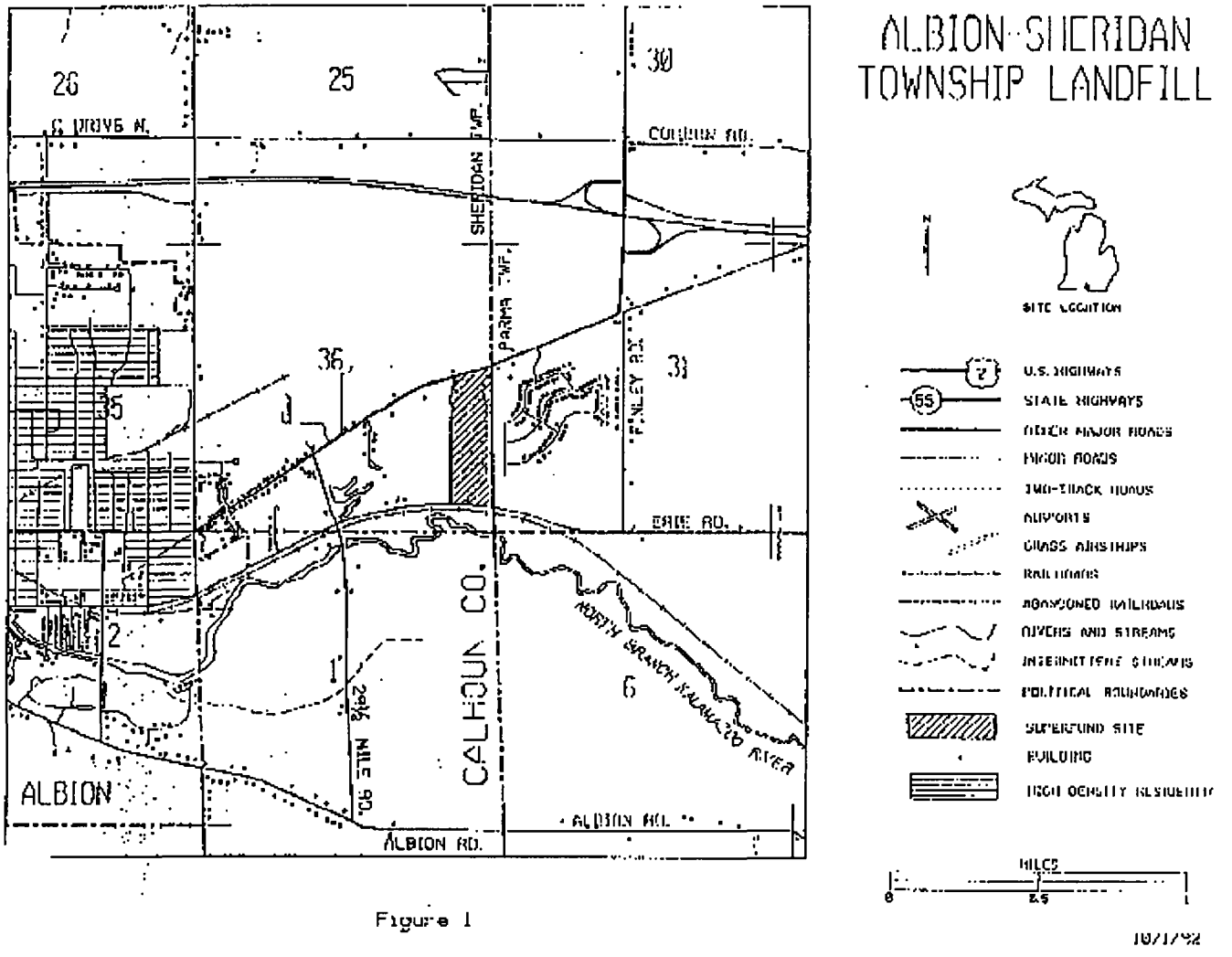
ALBION-SHERIDAN
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PARMA TWP.
FINLEY RD.
ERIE RD.
CALHOUN CO.
NORTH BRANCH KALAMAZOO RIVER
2½ MILE RD.
ALBION
ALBION RD.
ALBION RD.
SITE LOCATION
U.S. HIGHWAYS
STATE HIGHWAYS
OTHER MAJOR ROADS
MINOR ROADS
TWO-TRACK ROADS
AIRPORTS
GLASS AIRSHIPS
RAILROADS
ABANDONED RAILROADS
RIVERS AND STREAMS
INTERMITTENT STREAMS
POLITICAL BOUNDARIES
SUPERFUND SITE
BUILDING
HIGH DENSITY RESIDENTIAL
MILES
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Figure 1

PUBLIC HEALTH ASSESSMENT

ALBION-SHERIDAN TOWNSHIP LANDFILL
SHERIDAN TOWNSHIP, CALHOUN COUNTY, MICHIGAN

APPENDIX A.

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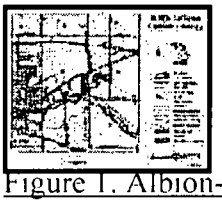

Figure 1. Albion-Sheridan Township Landfill

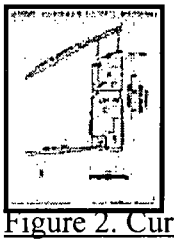

Figure 2. Current Approximate Property Boundaries

APPENDIX B.

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Table 1. Population of governmental units near the Albion-Sheridan Township Landfill site (1990 Census).

Governmental Unit	Population
Sheridan Township	2,139
Parma Township	2,491
Albion Township	1,256
Concord Township	2,408
City of Albion	10,056

Reference: 15

Table 2. Contaminants of concern at the Albion-Sheridan Township Landfill site.

METALS AND INORGANIC CHEMICALS	POLYCYCLIC AROMATIC HYDROCARBONS
Aluminum	Benzo(a)anthracene
Ammonia	Benzo(a)pyrene
Antimony	Benzo(b)fluoranthene
Arsenic	Benzo(ghi)perylene
Barium	Benzo(k)fluoranthene
Cadmium	Chrysene
Calcium	Dibenzo(a,h)anthracene
Chromium	Indeno(1,2,3-cd)pyrene
Cobalt	2-Methylnaphthalene
Copper	Naphthalene
Cyanide	Phenanthrene
Iron	
Lead	
Magnesium	OTHER SEMI-VOLATILE ORGANIC COMPOUNDS
Manganese	
Mercury	
Nickel	p-Chloro-m-cresol
Potassium	1,4-Dichlorobenzene
Sodium	Di-n-octyl phthalate
Vanadium	4-Methylphenol
Zinc	

VOLATILE ORGANIC COMPOUNDS	PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCBs)
Benzene	Heptachlor
Chloroethane	Heptachlor epoxide
1,2-Dibromo-3-chloropropane	Lindane
1,1-Dichloroethane	PCBs
2-Hexanone	
4-Methyl-2-pentanone	
1,1,1-Trichloroethane	
Vinyl chloride	

Table 3. Concentrations of contaminants of concern in groundwater from on-site monitoring wells at the Albion-Sheridan Township Landfill, 1980-1981.

Chemical	Date	Concentration (ppb)			Comparison Values (ppb)
		north	southeast	south	
Ammonia	1980	10	10,000	240	3,000[Ei]
	1981	70	38,000	230	
Calcium	1980	72,000	180,000	94,000	NA
	1981	50,000	150,000	110,000	
Chromium (total)	1980	ND (50)	ND (50)	ND (50)	10,000[R] (III) carcinogen (VI)
	1981	ND (50)	55	55	
Copper	1980	ND (20)	30	ND (20)	1,300[MG]
	1981	75	130	110	
Iron	1980	14,000	49,000	2,600	NA
	1981	12,000	49,000	1,000	
Lead	1980	70	ND (50)	ND (50)	15[PL], carcinogen
	1981	220	200	400	
Magnesium	1980	19,000	47,000	31,000	NA
	1981	16,000	55,000	55,000	
Potassium	1981	1,400	120,000	2,800	NA
Sodium	1980	6,600	99,000	45,000	NA
	1981	2,000	130,000	220,000	
Zinc	1980	ND (50)	23,000	110	3,000[R]
	1981	11,000	12,000	14,000	

Reference: 18

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
ND -- Not Detected (with detection limit)

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
MG -- EPA Safe Drinking Water Act Maximum Contaminant Level Goal
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day
PL -- EPA Proposed Action Level for Lead in Drinking Water

Table 4. Concentrations of contaminants of concern in groundwater from on-site monitoring wells at the Albion-Sheridan Township Landfill, from the remedial investigation, December 1992 - March 1993.

Chemical	Date	Maximum Concentration (ppb)		Reference	Comparison Values (ppb)
		upgradient	downgradient		
Ammonia	12/92	NU	203,000.J	3	3,000[Ei]
	3/93	ND (100)	28,000.J	1	
Arsenic	12/92	ND (2.2)	46.1	3	0.02[C]
	3/93	ND (1)	27.2J	1	
Barium	12/92	86.1J	462	3	700[R]
	3/93	92.9	468	1	
Calcium	12/92	113,000	174,000	3	NA
	3/93	135,000	172,000	1	
Chloroethane	12/92	ND (10)	ND (10)	3	NA
	3/93	ND (1)	0.9J	1	
Cobalt	12/92	ND (12.2)	6.7J	3	NA
	3/93	ND (9)	9.4J	1	
Copper	12/92	ND (7.8)	ND (7.8)	3	1,300[MG]
	3/93	ND (7)	7.J	1	
1,2-Dibromo-3-chloropropane	3/93	ND (1)	8	1	carcinogen
Di-n-octyl phthalate	12/92	2.J	ND (10)	3	NA
	3/93	0.9J	5.J	1	
Heptachlor	12/92	0.0096JP	ND (0.05)	3	0.008[C]
	3/93	ND (0.01)	ND (0.01)	1	
Iron	12/92	664	5,890	3	NA
	3/93	1,220.J	4,490.J	1	
Lead	12/92	ND (1.1)	ND (10)	3	15[PL], carcinogen
	3/93	4.7	ND (1)	1	
Magnesium	12/92	29,400	48,000	3	NA
	3/93	34,600	51,100	1	
Manganese	12/92	360.J	888	3	50[R]
	3/93	302	790	1	
Nickel	12/92	ND (32.2)	26.1J	3	carcinogen
	3/93	ND (18)	27.4J	1	
Potassium	12/92	9,150	56,900	3	NA
	3/93	14,200.J	57,000.J	1	
Sodium	12/92	84,300	753,000	3	NA
	3/93	105,000	125,000	1	

Zinc	12/92	ND (10)	ND (15.8)	3	3,000[R]
	3/93	ND (10)	66.9	1	

Chemicals that were never detected in this medium are not listed.
Shaded chemicals exceed comparison values.

upgradient -- north and east of the landfill
downgradient -- south and west of the landfill

J -- Estimated Value
P -- The two columns used in the Pesticide/PCB analysis had more than a 25% difference in the results reported. The lower value is reported.
ND -- Not Detected (with detection limit)

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available

Comparison Value Bases

Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
A -- EPA Drinking Water Health Advisory (Lifetime)
MG -- EPA Safe Drinking Water Act Maximum Contaminant Level Goal
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day
PL -- EPA Proposed Action Level for Lead in Drinking Water

Table 5. Concentrations of contaminants of concern in water from the residential well on the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppb)	Reference	Comparison Value (ppb)
Aluminum	10/92	47.1J	3	NA
Ammonia	10/92	28	3	30,000[Ei]
Arsenic	10/92	1.1J	3	0.02[C]
Barium	10/92	30.9	3	700[R]
Calcium	10/92	82,900	3	NA
Iron	10/92	92.2J	3	NA
Magnesium	10/92	24,000	3	NA
Manganese	10/92	63	3	50[R]
Sodium	10/92	17,600	3	NA
Zinc	10/92	34.1JN	3	3,000[R]

Chemicals that were not detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J, JN -- Estimated Value

NA -- None Available

Comparison Value Bases

Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
C -- ATSDR Cancer Risk Evaluation Guide, for 10^{-6} risk on lifetime exposure
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day

Table 6. Concentrations of contaminants of concern in leachate from the Albion-Sheridan Township Landfill.

Chemical	Date	Maximum Concentration (ppb)	Reference	Comparison Values (ppb)
Ammonia	12/92	473,000.J	3	3,000[Ei]
	3/93	450,000.J	1	
Arsenic	12/92	21.4J	3	0.02[C]
	3/93	12.6J	1	
Barium	12/92	126.J	3	700[R]
	3/93	202	1	
Benzene	12/92	6.J	3	1[C]
	3/93	7.J	1	
Benzo(a)anthracene	12/92	11.J	3	carcinogen
	3/93	ND (50)	1	
Benzo(b)fluoranthene	12/92	14.J	3	carcinogen
	3/93	ND (50)	1	
Calcium	12/92	67,200.J	3	NA
	3/93	77,100	1	
Chloroethane	12/92	ND (10)	3	NA
	3/93	5.J	1	
Chromium (total)	12/92	41.4J	3	10,000[R] (III) carcinogen (VI)
	3/93	61.7	1	
Cobalt	12/92	21.7J	3	NA
	3/93	23.9J	1	
1,1-Dichloroethane	12/92	ND (10)	3	carcinogen
	3/93	1.J	1	
Heptachlor epoxide	12/92	0.015JP	3	0.004[C]
	3/93	0.12JP	1	

2-Hexanone	12/92	150	3	NA
	3/93	ND (10)	1	
Iron	12/92	5,600.J	3	NA
	3/93	11,300.J	1	
Lead	12/92	3.3J	3	15[PL], carcinogen
	3/93	NU	1	
Lindane	12/92	0.032J	3	3[R], carcinogen
	3/93	ND (0.05)	1	
Magnesium	12/92	183,000.J	3	NA
	3/93	235,000	1	
Manganese	12/92	59.7J	3	50[R]
	3/93	86	1	
2-Methylnaphthalene	12/92	32.J	3	NA
	3/93	19.J	1	
4-Methyl-2-pentanone	12/92	19	3	NA
	3/93	ND (10)	1	
4-Methylphenol	12/92	400	3	carcinogen
	3/93	11.J	1	
Naphthalene	12/92	38.J	3	20[A]
	3/93	15.J	1	
Nickel	12/92	185.J	3	carcinogen
	3/93	279	1	
Potassium	12/92	450,000.J	3	NA
	3/93	566,000.J	1	
Sodium	12/92	1,600,000.J	3	NA
	3/93	1,800,000	1	
Vanadium	12/92	16.4JB	3	NA
	3/93	20.9B	1	
Vinyl chloride	12/92	14	3	2[E], carcinogen
	3/93	ND (10)	1	

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
P -- The two columns used in the Pesticide/PCB analysis had more than a 25% difference in the results reported. The lower value is reported.
ND -- Not Detected (with detection limit)
NU -- Unusable Data

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available

(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
A -- EPA Drinking Water Health Advisory (Lifetime)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day
PL -- EPA Proposed Action Level for Lead in Drinking Water

Table 7. Concentrations of contaminants of concern in surface soil collected within the fence on the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppm)	Reference	Comparison Values (ppm)
Aluminum	10/92	4,710	3	NA
Arsenic	10/92	52.2	3	0.4[C]
Barium	10/92	220	3	100[R]
Benzo(a)anthracene	10/92	0.35J	3	carcinogen
Benzo(a)pyrene	10/92	0.046J	3	0.1[C]
Benzo(b)fluoranthene	10/92	0.06J	3	carcinogen
Benzo(ghi)perylene	10/92	0.059J	3	NA
Benzo(k)fluoranthene	10/92	0.04J	3	carcinogen
Cadmium	10/92	3	3	1[E], carcinogen
Calcium	10/92	57,300	3	NA
Chromium (total)	10/92	63.3	3	2,000[R] (III) carcinogen (VI)
Chrysene	10/92	0.075J	3	carcinogen
Cobalt	10/92	4.J	3	NA
Copper	10/92	73.9	3	NA
Cyanide	10/92	1	3	40[R]
Indeno(1,2,3-cd)pyrene	10/92	0.17J	3	carcinogen
Iron	10/92	14,600	3	NA
Lead	10/92	160	3	carcinogen
Magnesium	10/92	12,300	3	NA
Manganese	10/92	832.J	3	300[R]
Nickel	10/92	39.4	3	carcinogen
PCBs	10/92	0.091	3	0.04[E], 0.09[C]
Phenanthrene	10/92	0.049J	3	NA
Potassium	10/92	1,390	3	NA

Sodium	10/92	485J	3	NA
Vanadium	10/92	13	3	NA
Zinc	10/92	278	3	600R

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior

Table 8. Concentrations of contaminants of concern in surface soil collected from the area around the residence on the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppm)	Reference	Comparison Values (ppm)
Aluminum	10/92	3,940	3	NA
Arsenic	10/92	11.1	3	0.4C
Barium	10/92	23.4J	3	100R
Benzo(a)anthracene	10/92	0.041J	3	carcinogen
Benzo(a)pyrene	10/92	0.043J	3	0.1C
Benzo(b)fluoranthene	10/92	0.11J	3	carcinogen
Benzo(ghi)perylene	10/92	0.037J	3	NA
Benzo(k)fluoranthene	10/92	0.12J	3	carcinogen
Calcium	10/92	34,300	3	NA
Chromium (total)	10/92	9.5	3	2,000R (III) carcinogen (VI)
Chrysene	10/92	0.057J	3	carcinogen
Cobalt	10/92	3.5J	3	NA
Copper	10/92	12.5	3	NA
Di-n-octyl phthalate	10/92	16.B	3	NA
Indeno(1,2,3-cd)pyrene	10/92	0.04J	3	carcinogen
Iron	10/92	11,600	3	NA
Lead	10/92	16.9	3	carcinogen

Magnesium	10/92	9,200	3	NA
Manganese	10/92	277.J	3	300[R]
Nickel	10/92	11.5	3	carcinogen
Phenanthrene	10/92	0.026J	3	NA
Sodium	10/92	158.J	3	NA
Vanadium	10/92	11.1	3	NA
Zinc	10/92	43.5J	3	600[R]

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior

Table 9. Concentrations of contaminants of concern in sludge (1980) and drum contents (1989) from the Albion-Sheridan Township Landfill.

Chemical	Date	Maximum Concentration (ppm)	Reference	Comparison Values (ppm)
Cadmium	1980	10	18	1[E], carcinogen
Chromium (total)	1980	250,000	18	2,000[R] (III) carcinogen (VI)
Cyanide	1980	2,100	18	40[R]
Iron	1980	45,000	18	NA
Lead	1980	280	18	carcinogen
Nickel	1980	1,000	18	carcinogen
Zinc	1980	150,000	18	600[R]
Ethylbenzene	1989	0.0312	5	200[R]
Tetrachloroethylene	1989	0.006	5	10[C]
Toluene	1989	0.017	5	400[R]
1,1,1-Trichloroethane	1989	0.0175	5	NA
Xylenes (total)	1989	0.319	5	400[Ei]

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior
C -- ATSDR Cancer Risk Evaluation Guide

Table 10. Concentrations of contaminants of concern in landfill wastes from the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppm)	Reference	Comparison Values (ppm)
Aluminum	12/92	2,960	3	NA
Antimony	12/92	523	3	0.8[R]
Arsenic	12/92	13.1	3	0.4[C]
Barium	12/92	74.8	3	100[R]
Benzo(a)anthracene	12/92	0.10J	3	carcinogen
Benzo(a)pyrene	12/92	0.086J	3	0.1[C]
Benzo(b)fluoranthene	12/92	0.17J	3	carcinogen
Cadmium	12/92	4	3	1[E], carcinogen
p-Chloro-m-cresol	12/92	4.1	3	NA
Chromium (total)	12/92	13.5	3	2,000[R] (III) carcinogen (VI)
Chrysene	12/92	0.11J	3	carcinogen
Cobalt	12/92	3.2J	3	NA
Copper	12/92	35.1	3	NA
1,4-Dichlorobenzene	12/92	0.21J	3	carcinogen
Iron	12/92	15,200	3	NA
Lead	12/92	208	3	carcinogen
Magnesium	12/92	11,500	3	NA
Manganese	12/92	366.J	3	300[R]
2-Methylnaphthalene	12/92	0.15J	3	NA
4-Methyl-2-pentanone	12/92	0.012	3	NA
4-Methylphenol	12/92	15	3	carcinogen
Naphthalene	12/92	1.4J	3	NA
Nickel	12/92	12.8	3	carcinogen
PCBs	12/92	0.21	3	0.04[E], 0.09[C]
Phenanthrene	12/92	0.26J	3	NA
Potassium	12/92	516.J	3	NA
Sodium	12/92	768.J	3	NA
1,1,1-Trichloroethane	12/92	0.003J	3	NA
Vanadium	12/92	9.1J	3	NA
Zinc	12/92	139	3	600[R]

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value

B -- Analyte Detected in Laboratory Blank Sample
NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior

Table 11. Concentrations of contaminants of concern in groundwater from off-site monitoring wells near the Albion-Sheridan Township Landfill.

Chemical	Date	Maximum Concentration (ppb)		Reference	Comparison Values (ppb)
		upgradient	downgradient		
Aluminum	12/92	442	ND (46.7)	3	NA
	3/93	ND (51.6)	2,530	1	
Ammonia	12/92	NU	6,340.J	3	3,000[Ei]
	3/93	ND (100)	27,000	1	
Antimony	12/92	ND (66.7)	71.4	3	4[R]
	3/93	ND (25)	ND (53)	1	
Arsenic	12/92	ND (2.2)	85.1	3	0.02[C]
	3/93	ND (1)	126.J	1	
Barium	12/92	79.1J	291	3	700[R]
	3/93	88.8	380	1	
Cadmium	12/92	ND (5.6)	ND (3.3)	3	7[E], carcinogen
	3/93	ND (4)	0.15J	1	
Calcium	12/92	104,000	143,000	3	NA
	3/93	120,000	131,000	1	
Chromium (total)	12/92	ND (10)	5.9J	3	10,000[R] (III) carcinogen (VI)
	3/93	ND (6)	6.5J	1	
Cobalt	12/92	ND (12.2)	8.2J	3	NA
	3/93	ND (5)	16	1	
Copper	12/92	10.4J	5.6J	3	1,300[MG]
	3/93	ND (13.8)	8.8J	1	
1,1-Dichloroethane	12/92	ND (10)	ND (10)	3	carcinogen
	3/93	ND (1)	0.2J	1	
Di-n-octyl phthalate	12/92	8.J	ND (10)	3	NA
	3/93	2.J	ND (5)	1	
Iron	12/92	637	2,550	3	NA

	3/93	835	3,420	1	
Lead	12/92	1.7J	2.6J	3	15[PL], carcinogen
	3/93	ND (1)	4.7	1	
Magnesium	12/92	28,300	41,000	3	NA
	3/93	31,100	41,900	1	
Manganese	12/92	345.J	443	3	50[R]
	3/93	363	411	1	
Potassium	12/92	48,700	32,200.J	3	NA
	3/93	65,300.J	38,600.J	1	
Sodium	12/92	58,800	84,100	3	NA
	3/93	64,900	102,000	1	
Vinyl chloride	12/92	ND (10)	ND (10)	3	2[E], carcinogen
	3/93	ND (1)	2	1	
Zinc	12/92	ND (10)	6.7J	3	3,000[R]
	3/93	ND (23.5)	19.4J	1	

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

upgradient -- north and east of the landfill
downgradient -- south and west of the landfill

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
ND -- Not Detected (with detection limit)
NU -- Unusable Data

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
A -- EPA Drinking Water Health Advisory (Lifetime)
MG -- EPA Safe Drinking Water Act Maximum Contaminant Level Goal
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day
PL -- EPA Proposed Action Level for Lead in Drinking Water

Table 12. Concentrations of contaminants of concern in water from residential wells near the Albion-Sheridan Township Landfill.

Chemical	Date	Maximum Concentration (ppb)		Reference	Comparison Value (ppb)
		upgradient	downgradient		
Aluminum	10/92	82.1	46.J	3	NA
Ammonia	10/92	38	1,200	3	3,000[Ei]
Arsenic	10/92	1.4J	1.7J	3	0.02[C]
Barium	10/92	118	77	3	100[R]
Calcium	10/92	118,000	93,200	3	NA
Heptachlor	10/92	0.011	0.022	3	0.008[C]
Iron	10/92	1,530	2,230	3	NA
Magnesium	10/92	32,200	28,200	3	NA
Manganese	10/92	185	104	3	50[R]
Potassium	10/92	6,140	2730	3	NA
Sodium	10/92	43,700	188,000	3	NA
Zinc	10/92	103.J	71.7J	3	3,000[R]

Chemicals that were not detected are not listed.

Shaded chemicals exceed comparison values.

upgradient -- north and east of the landfill
downgradient -- south and west of the landfill

B -- Also found in blank sample
J -- Estimated Value
NA -- None Available

Comparison Value Bases

Ei -- ATSDR Environmental Media Evaluation Guide, Intermediate-term exposure
C -- ATSDR Cancer Risk Evaluation Guide, for 10^{-6} risk on lifetime exposure
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day

Table 13. Concentrations of contaminants of concern in surface soil samples collected near the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppm)	Reference	Comparison Values (ppm)
Aluminum	10/92	17,700	3	NA
Arsenic	10/92	8.2	3	0.4[C]
Barium	10/92	212	3	100[R]
Benzo(a)anthracene	10/92	0.19J	3	carcinogen
Benzo(a)pyrene	10/92	0.21J	3	0.1[C]
Benzo(b)fluoranthene	10/92	0.25J	3	carcinogen
Benzo(ghi)perylene	10/92	0.21J	3	NA
Benzo(k)fluoranthene	10/92	0.19J	3	carcinogen
Chromium (total)	10/92	21.4	3	2,000[R] (III) carcinogen (VI)
Chrysene	10/92	0.25J	3	carcinogen
Cobalt	10/92	5.4J	3	NA
Copper	10/92	26.8	3	NA
Cyanide	10/92	1	3	40[R]
Dibenzo(a,h)anthracene	10/92	0.055J	3	carcinogen
Indeno(1,2,3-cd)pyrene	10/92	0.24J	3	carcinogen
Iron	10/92	13,400	3	NA
Lead	10/92	78.3	3	carcinogen
Magnesium	10/92	9,200	3	NA
Manganese	10/92	1,540.J	3	300[R]
Nickel	10/92	15.7	3	carcinogen
Phenanthrene	10/92	0.075J	3	NA
Sodium	10/92	305.J	3	NA
Vanadium	10/92	29.8	3	NA
Zinc	10/92	96.J	3	600[R]

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior

Table 14. Concentrations of contaminants of concern in surface water from the Kalamazoo River near the Albion-Sheridan Township Landfill.

Chemical	Date	Maximum Concentration (ppb)				Comparison Values (ppb)
		upstream		downstream		
		unfiltered	filtered	unfiltered	filtered	
Aluminum	10/92	38.9J	ND (42)	40.5J	ND (42)	NA
Arsenic	10/92	ND (2)	1.1J	ND (2)	ND (2)	0.02[C]
Barium	10/92	26	29.5	25.8	26.5	700[R]
Cadmium	10/92	ND (0.1)	0.55	ND (0.1)	0.13J	7[E], carcinogen
Calcium	10/92	79,400	76,000.J	75,600	78,200	NA
Chromium (total)	10/92	ND (9)	ND (10)	ND (9)	32.1	10,000[R] (III) carcinogen (VI)
Iron	10/92	109.J	116	88.2	86.3	NA
Magnesium	10/92	24,500	25,200.J	23,300	24,600.J	NA
Manganese	10/92	9.8J	16.7J	10.6	9.6J	50[R]
Potassium	10/92	1,650.J	ND (1,370)	1,510	621.J	NA
Sodium	10/92	7,640	7,990	7,740	8,170	NA
Zinc	10/92	7.2J	ND (9)	ND (5)	32.5	3,000[R]

Reference: 3

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
ND -- Not Detected (with detection limit)

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
A -- EPA Drinking Water Health Advisory (Lifetime)
PM -- EPA Safe Drinking Water Act Proposed Maximum Contaminant Level
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day

Table 15. Concentrations of contaminants of concern in surface water from wetlands adjoining the Kalamazoo River near the Albion-Sheridan Township Landfill.

Chemical	Date	Maximum Concentration (ppb)				Comparison Values (ppb)
		upstream		downstream		
		unfiltered	filtered	unfiltered	filtered	
Aluminum	10/92	8,980.J	ND (42)	1,120.J	ND (42)	NA
Arsenic	10/92	67.5	5.9	2.2J	1.2J	0.02[C]
Barium	10/92	307	54.9	66.4	59.5	700[R]
Cadmium	10/92	1.9J	ND (0.1)	0.29J	ND (0.1)	7[E], carcinogen
Calcium	10/92	215,000	97,300.J	130,000	87,100.J	NA
Chromium (total)	10/92	23	ND (10)	9.2J	ND (10)	10,000[R] (III) carcinogen (VI)
Cobalt	10/92	11.2	ND (10)	ND (10)	ND (10)	NA
Copper	10/92	28.4	ND (8)	ND (6)	ND (8)	1,300[MG]
Iron	10/92	124,000.J	1,420	4,640.J	88.4J	NA
Lead	10/92	12.6	ND (1)	11.6	ND (1)	15[PL], carcinogen
Magnesium	10/92	26,300	27,600.J	25,200	25,100.J	NA
Manganese	10/92	2,790	805.J	525	290.J	50[R]
Potassium	10/92	1,940.J	2,420	2,200	3,370	NA
Sodium	10/92	8,730	9,560	17,600	18,100	NA
Zinc	10/92	219	ND (9)	26.9	ND (9)	3,000[R]

Reference: 3

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
ND -- Not Detected (with detection limit)

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
A -- EPA Drinking Water Health Advisory (Lifetime)
MG -- EPA Safe Drinking Water Act Maximum Contaminant Level Goal
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child drinking 1 liter per day of water per day
PL -- EPA Proposed Action Level for Lead in Drinking Water

Table 16. Concentrations of contaminants of concern in sediment samples collected from the Kalamazoo River near the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppm)		Reference	Comparison Values (ppm)
		upstream	downstream		
Aluminum	10/92	2,710	2,270	3	NA
Antimony	10/92	18.6	15.J	3	0.8[R]
Arsenic	10/92	44.4	4.5J	3	0.4[C]
Barium	10/92	30.1J	22.1J	3	100[R]
Cadmium	10/92	ND (2)	38.5J	3	1[E], carcinogen
Calcium	10/92	46,900.J	58,600	3	NA
Chromium (total)	10/92	12.3	48	3	2,000[R] (III) carcinogen (VI)
Cobalt	10/92	9.5J	2.9J	3	NA
Copper	10/92	10.5	14.7	3	NA
Cyanide	10/92	ND (1)	1	3	40[R]
Iron	10/92	15,000	6,810	3	NA
Lead	10/92	7.1	4.9	3	carcinogen
Magnesium	10/92	14,100.J	15,400	3	NA
Manganese	10/92	239.J	604.J	3	300[R]
Mercury	10/92	0.07J	0.09J	3	NA
4-Methylphenol	10/92	0.11J	ND (0.66)	3	carcinogen
Nickel	10/92	19.3	21	3	carcinogen
Potassium	10/92	ND (420)	384.J	3	NA
Sodium	10/92	139.J	76.9J	3	NA
Vanadium	10/92	8.4J	7.8J	3	NA
Zinc	10/92	39.5	23.4	3	600[R]

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
ND -- Not Detected (with detection limit)

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior

Table 17. Concentrations of contaminants of concern in sediment collected from wetlands adjoining the Kalamazoo River near the Albion-Sheridan Township Landfill site.

Chemical	Date	Maximum Concentration (ppm)		Reference	Comparison Values (ppm)
		upstream	downstream		
Aluminum	10/92	6,070	5,470	3	NA
Arsenic	10/92	8.4	12.4J	3	0.4[C]
Barium	10/92	93.J	74.8J	3	100[R]
Benzo(b)fluoranthene	10/92	0.19J	0.48J	3	carcinogen
Benzo(k)fluoranthene	10/92	0.18J	0.33J	3	carcinogen
Calcium	10/92	66,000.J	226,000	3	NA
Chromium (total)	10/92	13	8.9	3	2,000[R] (III) carcinogen (VI)
Chrysene	10/92	0.15J	0.32J	3	carcinogen
Copper	10/92	19.J	15.9J	3	NA
Iron	10/92	16,000	34,800	3	NA
Lead	10/92	59.1	84.9	3	carcinogen
Magnesium	10/92	4,460.J	4,170.J	3	NA
Manganese	10/92	677.J	1,040.J	3	300[R]
Mercury	10/92	ND (0.2)	0.75J	3	NA
2-Methylnaphthalene	10/92	ND (1.3)	0.16J	3	NA
Phenanthrene	10/92	ND (1.3)	0.28J	3	NA
Sodium	10/92	200.J	367.J	3	NA
Vanadium	10/92	14.5J	10.J	3	NA
Zinc	10/92	130	184	3	600[R]

Chemicals that were never detected in this medium are not listed.

Shaded chemicals exceed comparison values.

J -- Estimated Value
B -- Analyte Detected in Laboratory Blank Sample
ND -- Not Detected (with detection limit)

NA -- None Available
carcinogen -- Carcinogen (EPA Class C or above) but no CREG available
(III) -- Chromium(III)
(VI) -- Chromium(VI)

Comparison Value Bases

E -- ATSDR Environmental Media Evaluation Guide
C -- ATSDR Cancer Risk Evaluation Guide (CREG)
R -- Concentration calculated from EPA Reference Dose (Chronic) by Ingestion, based on 10-kilogram child subject to pica behavior

Table 18. Number of observed[1] and expected[2] cases of invasive cancer among residents of ZIP Code 49224, by year of diagnosis, 1985-1991.

Year of Diagnosis	Observed Cases[1]	Expected Cases[2]	SMR[3]
1985	46	57.3	0.80
1986	58	62.9	0.92
1987	52	67.2	0.77
1988	38	67.0	0.57
1989	55	56.1	0.98
1990	45	56.1	0.80
1991	52	56.1	0.93
1985-91	346	422.7	0.82

Reference: 50

1. Includes cases reported to the Michigan Department of Public Health, Office of the State Registrar and Center for Health Statistics, by December 31, 1992.

2. Expected number of cases is based on ZIP Code population estimates and annual average age- and sex-specific incidence rates from the Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute.

3. SMR = Standard Mortality Ratio. Observed number of cases divided by expected number of cases (49).

RESPONSIVENESS STATEMENT

The Michigan Department of Public Health (MDPH) released a draft of this Public Health Assessment for public comment on November 22, 1995. The comment period lasted until December 22, 1995. No comments from the public were received by MDPH in this period.

FOOTNOTES

1. Reference numbers in parentheses refer to the list of References on pages 34-38.

2. As of October 1, 1995, the environmental protection and regulation functions of the Michigan Department of Natural Resources (MDNR) were transferred to the newly formed Michigan Department of Environmental Quality (MDEQ).

3. On April 1, 1996, the Michigan Department of Public Health (MDPH), Division of Health Risk Assessment (DHRA), was absorbed into the newly formed Michigan Department of Community Health (MDCH). The site history and background section of this document uses the departmental identifiers in effect at the time of the events.

4. Pica behavior is an abnormal consumption of nonfood materials, such as soil, most often seen in children under 5 years of age.

5. The topsoil samples were, with one exception, primarily sand, according to the RI report (1). The other sample, collected near the west side of the site, was primarily silt, and contained the highest off-site arsenic concentration, above the range of concentrations found in silt samples from that part of the state (29).

6. EPA has issued separate RfDs for manganese for ingestion in food and ingestion in water. No adverse health effects from ingestion of manganese in food have been documented well enough to determine a LOAEL. However, epidemiological studies have shown a connection between neurological disorders and exposure to manganese through the drinking water (37, 38).

7. The estimates were computed by multiplying the national age- and sex-specific cancer incidence rates compiled by the SEER Program by the number of people in each age group living in the ZIP Code area according to U.S. Census data and estimates. These products are then summed to give the total cancer rate estimate (49).

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